SCIENTIFIC AMERICAN SUPPLEMENT. No 1089

Scientific American, established 1845.
Scientific American Supplement, Vol. XLII. No. 1089.

NEW YORK, NOVEMBER 14, 1896.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

LANSTON'S MONOTYPE MACHINE.*

THE Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts, acting through its Committee on Science and the Arts, investigating the Lanston monotype machine, reports as follows:

In designing this machine the inventor had the object in view to produce individual types, set in lines of equal length, ready to be formed into columns and locked into chases, for use as a printing surface. Instead of setting previously prepared type, as in the old typesetting machines, he selected a process of casting types in the order of their use, and of setting this type into justified lines, and the lines into a column, to be subsequently separated into pages by hand.

The greatest difficulty encountered in all typesetting machines is the problem of the justification of the lines. This problem has been solved in this machine by making the word space types of a variable thickness, after there are vertical lines on the keyboard; those requiring the least space being placed into the first group, the next larger ones into the second group, and so on. To the first group is assigned a space of five units, to the second one of six units, and so forth. By the depression of each key, two holes are punched into the paper ribbon, in line with the marginal holes forming the rack. These punched holes record the location of the character on the keyboard, one hole recording the number of the vertical and the other that of the horizontal row of keys containing the letter struck. At the same time a mechanism is set into motion by the depression of each key for the object of measuring and indicating the space occupied by the accumulating letters. This mechanism is advanced by the depression of each key, by a number of units corresponding to the number of units of space occupied by the type, and this advance is indicated by an index hand. For each word space the minimum number of units admissible for this spacing is registered on this mechanism. When the accomplish this a number of stops is provided in the path of each of the two movements, which are operated by compressed air admitted to the corresponding pistons through channels which are closed by the paper ribbon, except where this ribbon is perforated. The location of the perforations determines which of the stops is to be brought into operation, and thus commands the position in which the plate of matrices is retained immediately before the type is cast. By means of a wedge the movement of the plate regulates the variable width of the type mould to correspond with the width required for the character.

The paper ribbon entering the type-making machine in a reverse direction, the record of the justifying addendum will precede each line. By a pneumatic device this record is caused to adjust a wedge, which regulates the width of the mould for each word space occurring on this line. By this means the proper length of the line is assured.

After the matrix plate has been arrested in that po-

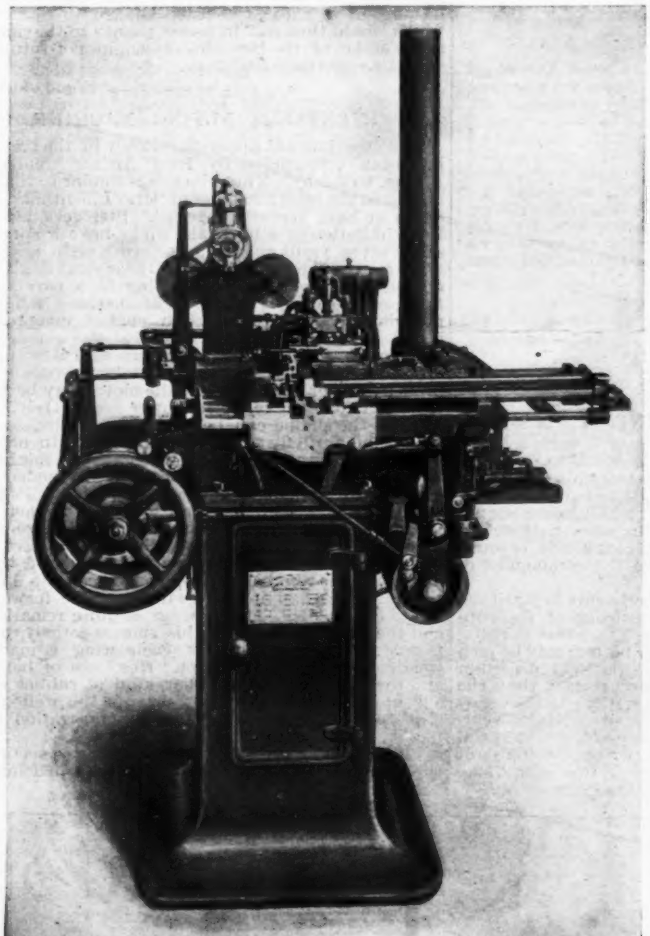


FIG. 1.—FRONT VIEW MONOTYPE CASTING MACHINE.
Size, 36×42 inches, including galley.

FIG. 2.—THE LANSTON MONOTYPE KEYBOARD.

first determining, by an ingenious plan, the thickness of the word spaces requisite to make each line of the proper length. This determination must, of course, precede the casting of the line, and this was presumably the initial reason for dividing the process of typesetting into two operations, each of which is performed on a distinct machine.

The first of these machines is in some respects similar to a typewriter, but instead of printing common letters, it is constructed to perforate a ribbon of paper, the locations of the perforations determining, Jacquard-card fashion, the characters which the operator puts into it. For each character two holes are punched through the ribbon, which has previously been provided with two rows of marginal holes that act as racks, by means of which the ribbon is advanced with the necessary regularity.

The keyboard is of a rectangular form, the keys being arranged in series of horizontal and vertical lines, and the characters placed on these keys in the following order:

The characters are divided into as many groups as

* Being the report of the Institute, through its Committee on Science and the Arts, on the invention of Tolbert Lanston.—From the Journal of the Franklin Institute.

dex shows to the operator that the accumulating types would fill a line so far that no additional syllable can be added, it also shows precisely how much space is required to fill the line. This space is distributed among the word spaces, the number of which is indicated on a dial, by finding the addendum required for each space to fill the deficiency. The requisite division is accomplished, mechanically, by means of a table attached to the index, and the resulting quotient is recorded at the end of each line on the paper ribbon.

While a copy is thus punched, the ribbon is wound upon a spool, and, when placed into the type-making machine, it will enter that machine with the end of copy foremost, passing through it in a reverse direction.

The matrices of the type-making machine are located on a rectangular plate, in two sets of rows, intersecting each other at right angles, in precisely the same order in which the characters are placed on the keyboard of the first machine. At every stroke of the machine this plate is caused to make a reciprocating motion in both directions, and each of these motions is so regulated that, on the return stroke, the movement is so limited that the desired matrix will be placed centrally over the mould in which the type is to be cast. To accom-

sition which will place the required character directly over the type mould, the matrix is more correctly centered than the pneumatic stops are able to do, by means of a taper plug entering into one of the conical centering holes which are located on the reverse side of the matrix plate, one opposite each matrix, and the molten type metal is injected into the mould. After congealing, the jet is cut off, the mould is opened, and the finished type is transferred, by an ingenious mechanism, to the galley, where it collects in the form of a column, and whence it is taken by hand to be made up into forms.

The investigating committee witnessed the operation of a machine at the printing office of the Philadelphia Inquirer, and found it to work exceedingly well.

The rapidity of the ribbon punching machine depends on the skill of the operator; but since the number of punching machines need not correspond with that of the type-casting machines, the rapidity with which the former machine is used has no direct bearing on that of the machine proper. An expert operator can easily furnish ribbon in excess of the capacity of the type-casting machine. It is, indeed, contemplated to have the writers use the punching machine to enable them to turn in copy on paper ribbons, ready for

the type-casting machine. The separation of the processes of making the ribbon copy and casting the type has obviously marked advantages.

The latter machine runs at a speed of about 110 strokes per minute. With the exception of a few strokes at the beginning of each line, each stroke produces a type. The capacity of the machine is stated to be between 4,000 and 4,500 ems per hour, and this capacity is self-evidently independent of the skill of the operator, whose function is that of producing the perforated ribbon.

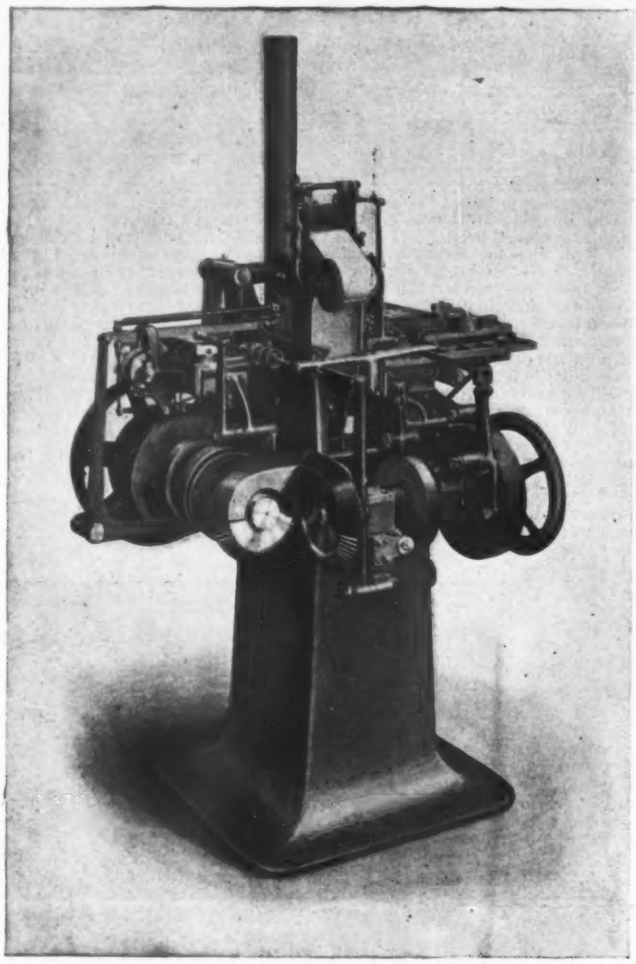


FIG. 3.—REAR AND SIDE VIEW MONOTYPE CASTING MACHINE.

Matter set up by this machine has the important advantage of admitting of subsequent corrections and alterations, being fully equivalent in this respect to matter set by hand.

This machine casts a perfect type in the ordinary sense of the word, which can be used in the finest magazine and book work.

After the matter set by this machine has been used, it may be remelted, or the type may be distributed and used in the ordinary way for hand work. The waste product of this machine can thus be advantageously utilized.

The investigating committee considers this invention as one of the highest order and importance.

The Franklin Institute, therefore, awards the Elliott Cresson Medal to Tolbert Lanston, of Washington, D. C., for his monotype machine.

Adopted at the stated meeting of the Committee on Science and the Arts, held Wednesday, April 8, 1896.

JOSEPH M. WILSON, President.
WILLIAM H. WAHL, Secretary.

G. MORGAN ELDRIDGE,
Chairman, Committee on Science and the Arts.

THE BALLOON AS AN ASSISTANT TO THE SUBMARINE BOAT.

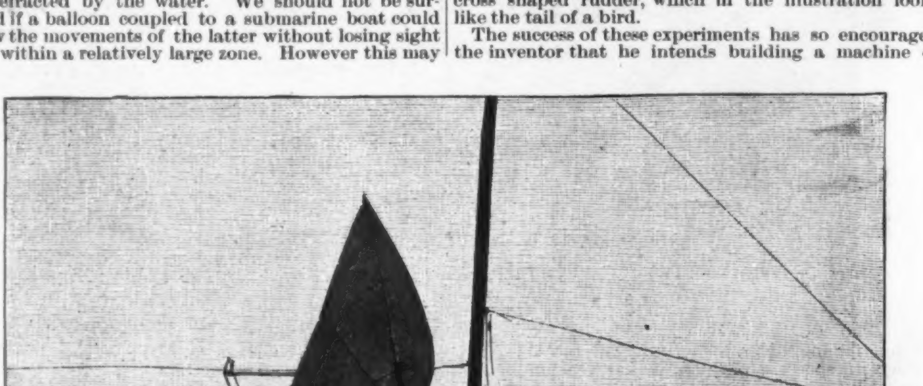
FOR air ships the most important function, and the most difficult to realize, is locomotion, while orientation and habitability are the most simple; on the contrary, for submarine boats, it is locomotion that is easy, while orientation is very difficult, and habitability relatively so, at least for a great depth and a somewhat prolonged period of time. Why should not we unite these two important factors of future maritime wars? They are apparently different, we admit, but at first sight only, for at bottom they are twin brothers, begotten by the same thought, that of traversing ocean and air. The submarine boat is blind, but it can move with ease; the balloon, on the contrary, sees clearly, but it cannot move about as it wishes, although notable progress has been made in this direction. Are they not like the blind man and the paralytic of the fable, and may they not, by lending mutual aid and by joining their efforts and their individual faculties, become by this union stronger than either could be, taken by itself? Odd or paradoxical as [this idea] may appear to you à priori, we ask of you only a few minutes to show all the advantages that naval strategy could gain from the coupling of these two elements, in appearance so dissimilar. Submarine boats are now furnished with optical tubes for exploration of the horizon. But what are these posts of observation, which rise scarcely a few yards from the surface of the water and from which the least wave hides the enemy that we wish to observe, in spite of all our optical tubes and telescopic towers? What are they beside the marvelous outlook stations that may be launched into the air, to whatever height we wish, higher than the military masts of our ironclads, higher than any tower we can build, into a region inaccessible to the enemy's projectiles, where we may move about above all, and whence we may view an endless horizon that grows in extent continually as we rise? From such a height, whence we may observe with marvelous accuracy the least movements of the enemy, we may transmit our orders to the poor "marine moles"—as the engineer Toselli has so well called them—which then become simply passive and docile instruments, the arms that strike, while the balloon is the head that commands, because it sees and thinks. There will be the commander of the aerohydric twin.

We do not know whether experiments in maritime ballooning have added to our knowledge of the submarine depths; but it is asserted as a fact that in rising vertically above a sheet of water the bottom may be seen the better the higher one goes, at least within certain limits. This is easily explained by the fact that the more the visual rays approach the vertical, the less they are refracted by the water. We should not be surprised if a balloon coupled to a submarine boat could follow the movements of the latter without losing sight of it, within a relatively large zone. However this may be, the officer stationed in the airship could from his post of observation direct at will the movements of the immersed vessel, which, holding the balloon captive, would lead it in turn in the direction indicated by the order from the commander at his post. By means of the connecting cable, electric energy could be transmitted from the submarine boat to the airship, and operate a motor that would give to the balloon a movement of translation that would allow it the better to follow the submarine boat, especially in the case of a contrary wind or in case of retreat, if the enemy should give chase. We have the firm conviction that the creation of submarine boats, by facilitating experiments in ballooning in the open sea, will soon give a new and powerful instrument to aeronautic science. To give to this association of balloon and submarine boat a greater effectiveness, it would be preferable to have a flotilla of submarine boats in charge of a single airship, one of the boats being specially organized and equipped for the service of the airship, whose connecting line it would carry. It would serve alike as a central communicating station, toward which would converge all the connecting cables of the submarine sentinels whose different telephonic lines would run to the balloon. The different submarine boats would become, for the commander, so many dirigible vessels, like dirigible torpedoes. This enormous and powerful aerial with a torpedo at the end of each of its tentacles would group together and practically realize, we believe, the sum of the desiderata for the movable and fixed defense of ports and coasts, the cruisers remaining as an advance guard and the coast batteries as the last line of defense of the seashore. Instead of controlling, from the fixed level of a fort, sunken torpedoes located at fixed points, as now done in the defense of coasts and ports, we could, by the simultaneous employment of balloons and submarine boats, control from a movable point in space, as high as we wish (500 to 600 yards would seem most preferable), a series of torpedoes, movable in all directions, whose position could be altered at will, at any instant, and which could be sent at any moment and in any direction against an enemy. We would be able, in this way, to hold the enemy's fleet at such a distance from the coast that the range of their guns would be insufficient to cause the least damage to our cities, which would thus rest in peace, thanks to the simultaneous action of the two different engines of future naval wars.—Revue Scientifique.

STENTZEL'S FLYING MACHINE.

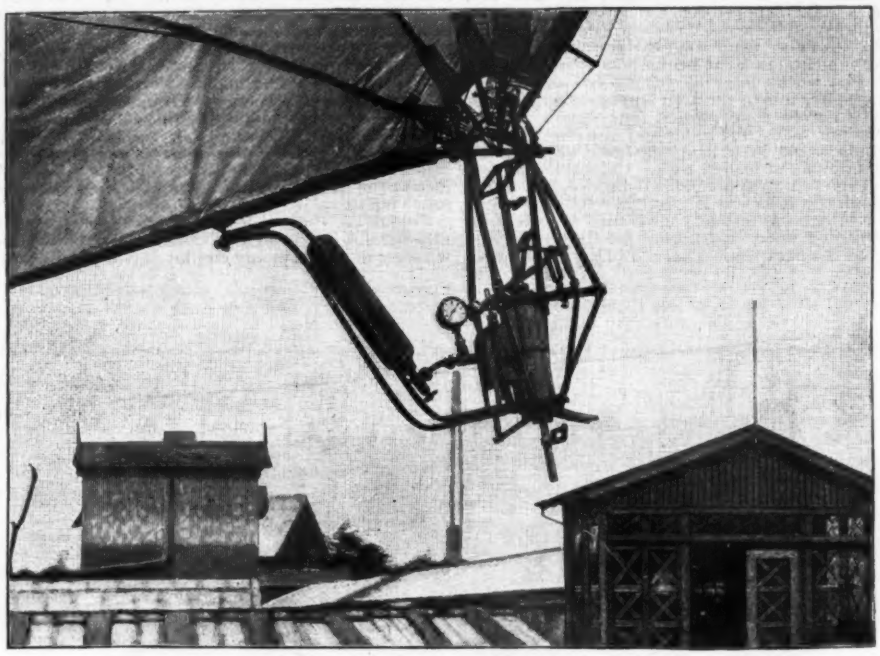
THE experimental apparatus shown in the two cuts has been constructed by Herr Arthur Stentzel, of Altona, Germany. The principle is similar to that embodied in the later machines of Otto Lilienthal, whose death we have recently recorded. Stentzel's machine is the imitation of a bird; the wings have a spread of about seven yards and their surface is eight and two-fifths square yards. They move through an angle of 70 degrees, and are curved according to a parabola in the proportion of 1 to 12. The machine weighs 75 pounds and is driven by an engine invented by Stentzel. Compressed carbonic acid gas is employed as a motive agent. With a pressure of 5 atmospheres one horse power is obtained, and by increasing the pressure to 7 or 9 atmospheres the motor may be made to yield two or three horse power respectively. The speed of the engine can be readily controlled so that the machine will fly at varying velocities. In order to guide the apparatus in its flight so that it might not be damaged by collisions, the inventor suspended it on a safety cable. When one horse power is applied, the machine will travel forward about 10 feet at each flapping of the wings. With one and one-half horse power a free flight is obtained, that is, the machine rises completely, so that none of its weight is supported by the cable, and the number of flappings increases to 1·3 per second. Each flapping drives the machine forward 13 feet. The elasticity of the wings is quite remarkable, and the inventor attributes his success largely to this feature. The main stay of each wing is made of weldless steel tubing, the ten "ribs" are of bamboo, and the covering of a peculiar kind of rubber cloth. The apparatus is steered by means of the well-known cross shaped rudder, which in the illustration looks like the tail of a bird.

The success of these experiments has so encouraged the inventor that he intends building a machine of



STENTZEL'S FLYING MACHINE.

sufficient power to lift and carry a person in its flight. This apparatus will weigh from 175 to 225 pounds, the surface of the wings will be from twenty-one to twenty-four square yards, and a motor of four and one-half horse power will be employed. Since the center of



MOTOR OF STENTZEL'S FLYING MACHINE.

gravity is in the axial plane and below the wings, the machine has great stability.

Herr Stentzel believes that man's muscular power, which does not exceed one quarter horse power, will never be sufficient to lift a weight of 350 pounds for any considerable length of time, and that for this purpose a mechanical power of at least four and one-half horse power is required. Compressed carbonic acid gas is a very convenient motive agent, on account of its lightness. The inventor's aim is to construct a stable and reliable flying machine in which the available mechanical power will be used to the best advantage.

Further developments only can prove the correctness of Herr Stentzel's solution of the flying machine problem. In any event, the inventor's new experiments will be watched with great interest by the general public as well as by scientists.—Illustrirte Zeitung.

COMBINED FLUSH-SIDE COLD SAWING AND ENDING-UP MACHINE.

WE illustrate a combined tool recently introduced by Messrs. Isaac Hill & Son, of the St. George's Engineering Works, Wood's Lane, Derby, which is intended more especially for use in constructional iron and steel works. The peculiarity of the machine consists in the fact that it may be used at will as either a cold saw or an ending-up machine. In Fig. 1 it is represented as arranged for cold sawing. The feed is variable and self-acting at all points, while the saw spindle is driven by steel gearing instead of the usual worm and wormwheel, thus greatly reducing the frictional losses. This arrangement of driving the saw spindle lends itself to a ready means for altering the speed used in sawing to a much quicker and correct speed for ending up bars. It will be noticed that the driving is effected by a belt and compound spur gear, one train of gear (wheel and pinion) being dropped out of gear and a spare wheel substituted when speeding up is necessary, this wheel being shown to the front of the machine in Fig. 1. The work table is so arranged that for facing or ending up it is 6 in. below the center of the spindle, as shown in Fig. 2; while for cross cutting work (in sawing) the table is raised by a making up piece to bring it up to the proper height. When facing is required, the saw is removed from the spindle, and the facing head is attached as represented in Fig. 2. The belt pulleys measure 29 in. by 5½ in. face, and the machine is intended to saw sections up to 28 in. by 8 in., while the facer head is 16 in. in diameter. For our engravings we are indebted to Engineering.

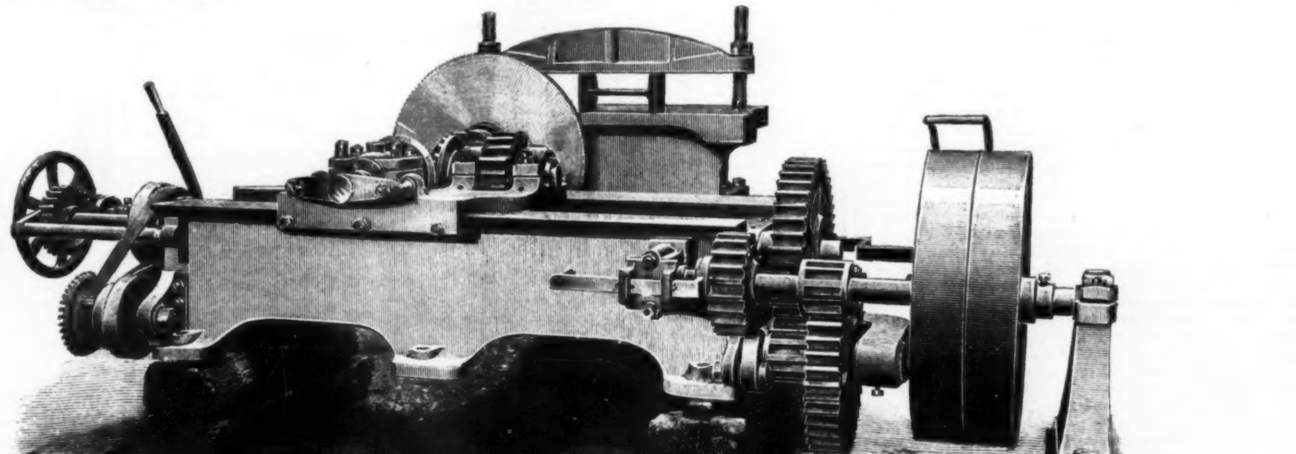


FIG. 1.

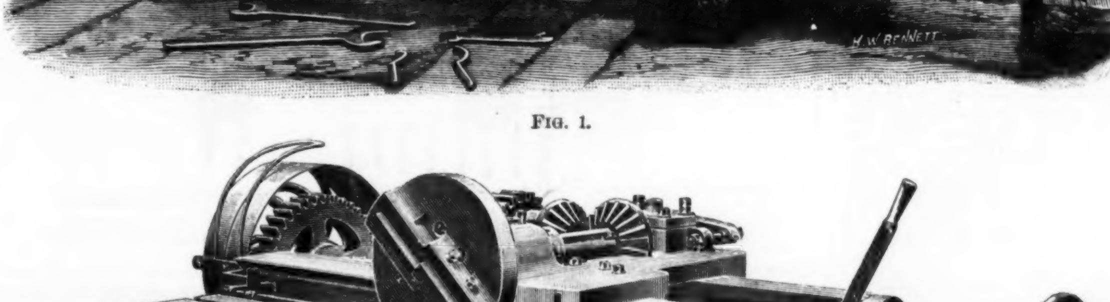


FIG. 2.

COMBINED FLUSH-SIDE COLD SAW AND ENDING-UP MACHINE.

GOOD LIGHT RAILWAYS.

THE kingdom of Belgium, divided into nine provinces, has an area of 2,945,591 hectares (11,373 square miles), inhabited by a population of 6,341,958, according to returns up to the end of last year. The total length of standard gage railways, which are chiefly worked by the state, is 4,556 km. (2,831 miles); and that of the vicinal or secondary lines 1,630·7 km. (nearly 1,014 miles), showing the latter to be 35·7 per cent. of the former. Compared with France, in which country economic railways have also made considerable way, Belgium has a far larger proportion of light lines, the latest statistics for the former country showing 36,595 km. (22,738 miles) of standard gage and 3,871 km. (2,405 miles) of economic railways, the length of the latter being about 16 per cent. of the former.

The Journal of June 21, 1895 (vol. xliii, p. 726), contained an article entitled "The Working of Belgian Vicinal Railways," describing the object and operations of the Société Nationale des Chemins de Fer Vicinaux, which was formed about ten years ago, under the auspices of the Belgian government, to raise funds, contributed by the state, the provinces, the communes, and individuals interested (each in proportion varying within fixed limits), for making and stocking light lines, not merely in districts where their traffic was almost a foregone conclusion, but also in those, shut out from means of communication, that would require development before a return on outlay could be expected.

The article above referred to brought the results achieved, as regards the construction and extension of lines and the financial condition, to the end of 1894; and the object of the following observations will be to record the progress that was achieved, both materially and financially, during last year. When that year opened there were 60 vicinal lines in operation, of which 40 showed better financial results than during the previous year's working, 36 yielded a dividend higher than that of 1894, and the working of only four others showed a balance on the wrong side. At that date the society possessed the concessions of 66 lines, 1,341½ km. (833½ miles), long, of which 62, measuring nearly 1,250 km. (776¾ miles), were actually in operation.

Compared with the above figures, at the beginning of the present year there were 63 lines in operation, of which 35 showed better financial results than during the previous year's working, 31 yielded a higher dividend than that of 1894; and of the four others, one earned sufficient to completely pay off former loss, while the balance shown by a second will go toward

paying past debts. Of the two remaining lines, which still show a balance on the wrong side (though the balance is smaller than before), that between Bourcy and Houffalize, in the Ardennes, made a loss of 1,229 francs (£49) as compared with 2,386 francs (£95) in 1894, and that between Arlon, the chief town of Belgian Luxemburg, and Ethe, one of 1,325 francs (£53) last year, against 4,016 francs (£160) in 1894.

It may here be mentioned that, although the society's lines have earned collectively, up to the end of last year, the large sum of 5,903,465 francs (£236 138), the total loss on working since operations were started only amounts to 81,000 francs (£3,240); and the general reserve fund formed to cover such loss has attained the sum of 409,661 francs (£16,386), the individual reserve funds of each line together amounting to more than half that sum. At the present time, among the lines which have been in operation at least a year, 23 pay a dividend of more than 3½ per cent., 4 others one of more than 3 per cent., and 11 others one exceeding 2½ per cent. Last year the nominal capital of the society was increased, by the issue of 35,000,000 francs 3 per cent. debenture bonds, to 98,000,000 francs (£3,920,000).

In the course of 1895, the Société Nationale obtained 15 concessions of new lines or extensions, including the Haecht-Aerschot-Tirlemont line of 45½ km., one of 30 km. between Ypres and Neuve-Eglise, one of 22 km. between Wavre and Braine-l'Alleud, near the field of Waterloo; one of 12 km. between Onoz and Fleurus, one of 18 km. between Tongres and Fexhe-le-Haut-Clocher, another between Tongres and Lanaeken, and a line of 14 km. between Boussu in Hainaut to the French frontier toward Bavay.

With other lines and extensions, the total length at the beginning of the present year attained 1,558½ km. (968 miles), made up of 81 lines and extensions, reduced by fusion and modifications to 75 lines of 1,554½ km. During the present year four other concessions have been obtained, including that of a line 17 km. long between Louvain and Tervueren, bringing up the total length to 1,573 km. (977 miles).

There are at present in operation 65 lines, measuring 1,325 km. (823 miles); and 10 others are under construction. Of the former, 63 are worked by steam locomotives, one by horses, and one (that between Brussels and the Petite Espinette, 12 km. long and of meter gage) by electricity on the trolley system, which has given such satisfactory results that the adoption of the same system is under consideration for the lines of the center district and those in the environs of Charleroi. Besides the lines actually conceded, 82 others, of 1,380 km. (857½ miles), are under consideration by the government.

During last year, five new junctions were effected between vicinal and standard gage lines, bringing up the number to 70, including 48 with the Belgian state system. Moreover, 17 new private sidings were made during the same period, bringing up the number to 123 of 59 km. (36 miles) collective length. Of the above number, 83 afford communication with industrial establishments, such as works and quarries, while 39 are purely agricultural.

Up to the end of last year the total amount spent in making the lines and providing them with fixed plant and rolling stock was 52,544,455 francs (£2,101,778). The total receipts from last year's working amounted to 5,903,465 francs (£236,138), and the expenses to 4,091,110 francs (£163,644), giving a coefficient of 69·3 against 70·57 in 1894. It is noticed that among the lines which carry both goods and passengers, in 24 there was an increase and on 4 a decrease in both classes of traffic, while on 15 there was an increase of passengers, with falling off in goods, and in 4 just the reverse.

While the number of kilometers run last year was 6,149,263, against 5,802,132 in 1894, being an increase of 6 per cent., the number of personal accidents was less in 1895 than in 1894; and, as usual, the most frequent causes were suicide, drunkenness, deafness and imprudence. There was no loss of life to passengers traveling by the lines; but three were injured, two while getting into or leaving a train in motion and one while passing from one carriage to another. Nor were there any fatal accidents to the employes, but one was injured while shunting a train. All the 31 fatal accidents occurred to persons unconnected with and not traveling by the lines, 21 through drunkenness and deafness, and 4 through crossing the line in front of a train.—Journal of the Society of Arts.

A CONCRETE ARCH BRIDGE OF FORTY FEET SPAN.

WE are indebted to the courtesy of Mr. A. Geisel, C.E., of St. Louis, for the following illustrations and particulars of a concrete highway bridge of forty feet span, which was recently built across Richmond Creek, in the city of Belleville, Ill. The plans, which were drawn by Mr. Geisel, were offered in competition with other designs for iron, stone and brick bridges. They were accompanied with the lowest bid; but it was not until the fears of the city council had been overcome by the designer offering to build the bridge at his own expense and risk, and without any compensation until the bridge was tested, that the contract was awarded.

The ground upon which the bridge was to be erected was a black, soft soil saturated with water. Borings made showed no solid ground until rock was reached at a depth of 27 ft. below the creek bed. White oak piles were then driven to the rock, and were spaced 3½ ft. apart under the abutments and wing walls. These piles were 12 in. in diameter, 25 ft. long, and were sawed off at a point 2½ ft. below the bed of the creek. The concrete trench was then dug out 1 ft. below the heads of the piles.

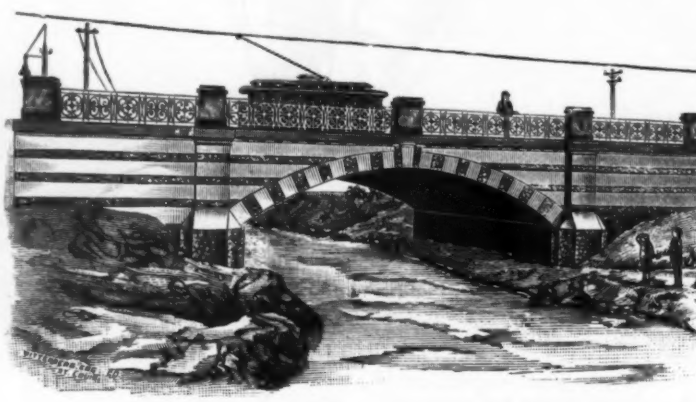
The arch is of 40 ft. span and 7 ft. rise; the total width is 52 ft., including 36 ft. of roadway between curbing and two 8 ft. sidewalks. Including the wing walls, the bridge is 85 ft. long, and the total height, from bottom of concrete foundation to top of roadway paving, is 24 ft. The arch itself is 2½ ft. thick at the skewbacks, increased to 2 ft. 9 in. at the haunches and decreased to 2 ft. at the crown.

The method of construction may be described as follows: On top of the retaining walls, on both sides, platforms for mixing the concrete extended the full length of the arch. For construction the arch itself was divided into five sections on each side of the key, and templates made to conform to each section were fastened to the centers for the full length of the arch and removed to the next joint after the concrete had set for three days. Owing to the strength of the concrete used, and to avoid imposing too heavy a weight upon the foundations, instead of a solid haunching, six 2 ft. walls were built, resting upon the arch and affording a solid support for the guttering and the street railway. The space between these walls was filled with clean clay made solid by ramming.

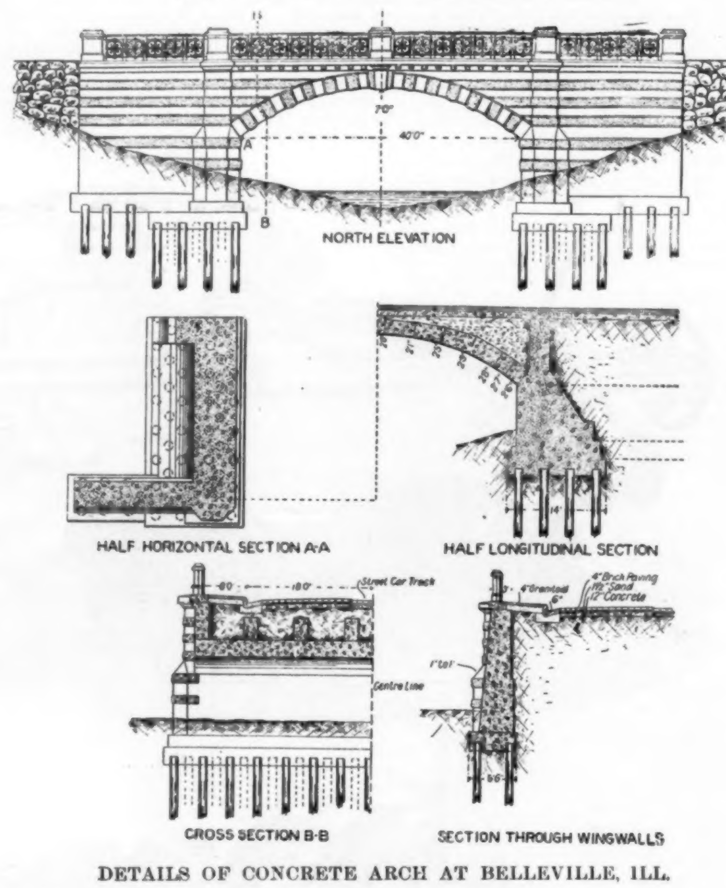
Soon after completion the bridge was opened to travel, and two weeks later it was tested, as follows: Along the center line of the arch and covering an area of 15 × 30 ft. were concentrated four wagons loaded with macadam, one street roller and one electric street car weighing 68,000 lb. in the aggregate, or about 151 lb. per square foot of loaded area. Careful levels were taken and showed no appreciable deflection under this load, though the load was left in place for two hours. When the bridge was formally dedicated at least 1,000 people crowded upon it, hanging on the railing and standing on the parapets. This crowding was equivalent to an evenly distributed load of 100 lb. per square foot over the whole area of the bridge.

The concrete for the various parts of the bridge was mixed as follows: The haunching walls, concrete underneath the roadway, spandrel walls and the abutments consisted of 1 part Louisville cement, 3 parts Mississippi River sand and 5 parts crushed macadam. The same materials and proportions were used in the arch, except that Dyckerhoff German Portland cement was used in place of the Louisville cement. Crushed granite and Portland cement were used for the sidewalk, curb and gutters. Two and a half parts of sifted crushed granite to 1 part Portland cement were used for the coping, brackets, and exposed parts of the brackets. Plastering was done with 1 part Portland cement to 2 parts sifted Meramec sand, and for the rough finished surfaces 1 part Portland cement to 2 parts fine gravel.

The advantage of this style of construction lies in the fact that, under proper supervision, it can be done by common labor, that it is cheap and yet of a handsome appearance. If care be taken that "proper supervision" is exercised, this is a departure in construction of smaller highway bridges which certainly has much to recommend it to city and county commissioners.



CONCRETE ARCH AT BELLEVILLE, ILL.



DETAILS OF CONCRETE ARCH AT BELLEVILLE, ILL.

PROCESSES FOR THE NICKEL PLATING OF WOOD.

THE nickel plating of wood, if not an important industry in this country, is, at least, an interesting one, and one which in Germany at any rate has attained considerable proportions. There are so many directions in which nickel coated wood may be usefully employed, even though none of them, perhaps, might absorb a great quantity of the metal.

In a recent issue of Dingler's Polytechnisches Journal, 298 (3), page 72, there is an interesting résumé of all the processes of nickel plating on wood which are now being exploited. Those of our readers who are commercially interested in this phase of electroplating may usefully consult the paper in its entirety. To give an idea of the modus operandi observed, we may make the following extract.

First of all, the articles which are to be plated with nickel must be coated with metal. In the process which is most commonly employed, three solutions are made use of, namely, (A) 1½ grammes of caoutchouc slicings are dissolved in 10 grammes o. carbon bisulphide and 4 grammes of melted wax are poured into the solution; a mixture consisting of 5 grammes phosphorus in 60 grammes of carbon bisulphide, with 5 grammes of turpentine and 4 grammes of powdered asphalt, is then added and the whole shaken. (B) Two grammes of silver nitrate are dissolved in 600 grammes of water. (C) Ten grammes of chloride of gold are dissolved in 600 grammes of water. The conducting wires are attached to the article, which, after being immersed in the first solution, is allowed to dry. The second solution is poured over it, and it is kept suspended until the surface has a dark luster, when it is rinsed with water and treated in a similar manner with the third solution. The surface has now a yellowish sheen, and the wood is sufficiently prepared for electrolytic deposition. Langbein's dry process consists in quickly pouring over the article a collodion solution of potassium iodide, diluted with an equal volume of ether alcohol; when the layer is just about to set, the wood is laid in a weak solution of silver nitrate, light being excluded. As soon as a yellow color appears, the wood is rinsed, exposed to sunlight and covered with copper; it is then ready to be nickel

plated. The wood may also be treated with immersion in an ethereal solution of paraffin or wax, and when the ether has evaporated, fine graphite is powdered over them, or the wax is covered with bronze powder and all unevenness of surface removed. When the articles are to be electrolytically coated with copper, they are placed in a bath, the composition of which varies with the current employed generally; it consists of 30 liters of 18 per cent. copper sulphate solution and 1½ liters of 66 per cent. sulphuric acid.

When a sufficient amount of copper is deposited, the articles are ground, polished and nickel plated in a bath composed of 500 grammes of ammonium nickelous sulphate, 50 grammes of ammonium sulphate and 10 liters of distilled water. If the blue litmus paper be quickly reddened by this solution, the acidity is reduced to such a point by addition of ammonium chloride that the reddening is only slowly developed.—English Electrical Review.

A METHOD OF DESTROYING THE WORKS OF AN ENEMY.

IN a besieged place, after the enemy has made himself master of the covered way, and of all of the out-

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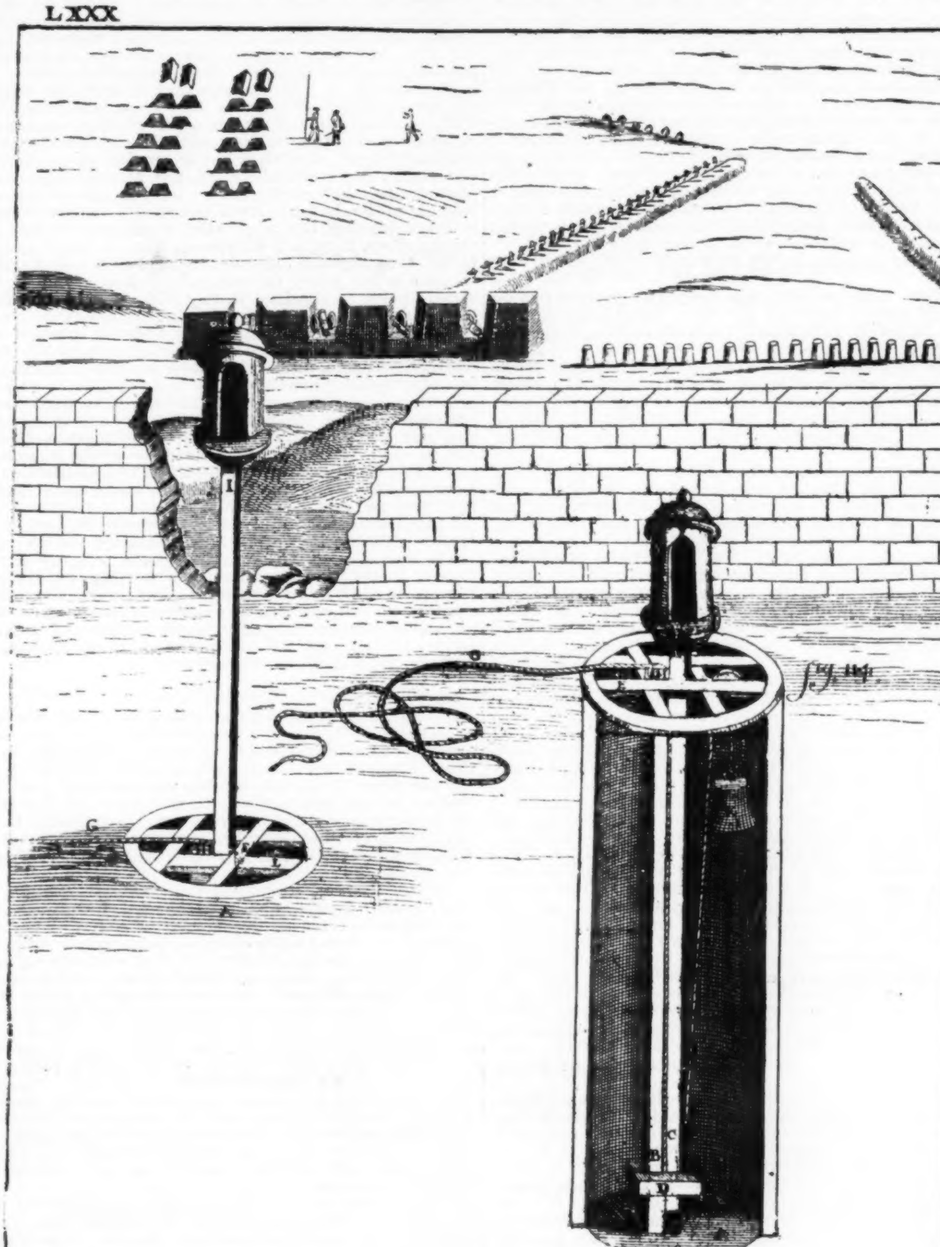


A METHOD OF DESTROYING THE WORKS OF AN ENEMY.

works, and, through his guns, has ruined your flanks and parapets, you cannot, without great risk, discover the works that he has constructed for passing the moat. Since it is nevertheless very important that you shall be informed of them, you are often obliged to sacrifice good subjects by sending them on a reconnoiter. Such good subjects are always rare, especially at the end of a siege, and as they must be exposed to all the fire of the parallels of the besiegers in order to acquit themselves of their commission, it often happens that they are killed or that fear prevents them from seeing objects just as they are, or from giving themselves time to sufficiently examine them. They will make false reports to you, and if the reports are faithful, it must be confessed that they will cost you very dear. It was, therefore, as a precaution against the inconveniences of such a situation that Mr. Grollier devised the present machine.

Along the rampart on the attacking side one excavates the dry wells marked A, in which are placed the two long pieces of wood, B C, in such a way that the piece, B, shall be firmly held in the ground at the bottom of the well by its lower end, and by the cross pieces, E, at its upper end, and that the second piece, C, shall be free and capable of sliding up and down along the first. This piece, C, is provided at the bottom with a slider, D, passes freely through the opening in the center of the cross pieces, E, and is drawn upward by the rope, G, which is attached to its lower extremity, passes over the pulley, H, and is maneuvered by soldiers.

At the top of the piece of wood, C, there is a sentry box, I, which is bulletproof, and which is occupied by the engineer who wishes to discover the works of the enemy. In raising the piece, C, by manual power, as I have already said, the box and the engineer are raised at the same time, and, as the piece, C, is quite long, the engineer is raised to a sufficient height to allow him to survey the entire extent of the moat. After he has been raised to the highest point, he can, without much risk, observe what is going on through the small apertures in his box, which protects him against bullets; and after he has sufficiently examined everything, he gives the signal that has been agreed upon, and is then lowered through the slackening of the rope, G. This machine can be used as many times as necessary in order to obtain news of the besiegers, and the person who employs it risks nothing but shot from cannon. But this is not one-hundredth of the risk to which he would be exposed were he to have to fear the fire of musketry. Moreover, the enemy, not being precisely informed as to the place where your wells are situated, does not have his guns pointed at the machine when it is raised and makes its appearance, and after he has learned the fact, the gunner would have to be very skillful and his piece very accurate to strike within the small space occupied by the box.

To this machine may be added the counterpoise, K, which will facilitate the working of it, inasmuch as the rope, being attached to the lower end of the piece of wood, C, and passing over the pulley, L, will always draw the piece of wood, C, upward. For this reason, one or two men will suffice to maneuver it.—From Reçueil d'Ouvrages Curieux, 1733.

There is on foot a project for piercing the Alps at the Great St. Bernard and joining the Italian station of Aosta with Martigny. The cost is estimated at forty million francs, and the length of the top tunnel would be only 3 kiloms. This line would be of great importance to Turin, but, owing to the steep gradients necessary, could not enter into serious competition with the Simplon route. The latter would effect great economy of time and distance in the trans-continental service, and would carry the Indian mails.

[Continued from SUPPLEMENT, No. 1088, page 17396.]

THE MANUFACTURE OF CHLORINE.*

DEACON'S PROCESS WITHOUT MANGANESE.

THOSE of you who were present at the last meeting of the British Association in this city will remember that this section had the advantage of listening to a paper by Mr. Weldon on his chlorine process, and also to another highly interesting paper by Mr. Henry Deacon, of Widnes, "on a new chlorine process without manganese." And those of you who came with the then president of the section (Prof. Roscoe) to Widnes to visit the works of Messrs. Gaskell, Deacon & Company, will well remember that at these works they saw side by side Weldon's process and Deacon's process in operation, and no one present will have forgotten the thoughtful flashing eyes and impressive face of Mr. Deacon when he explained to his visitors the theoretical views he had formed as regards his process.

Mr. Deacon had made a careful study of thermochemistry, which had been greatly developed during the preceding decade by the painstaking, accurate and comprehensive experiments of Julius Thomsen and of Berthelot, and had led the latter to generalizations which, although not fully accepted by scientific men, have been of immense service to manufacturing chemistry.

Mr. Deacon came to the conclusion that if a mixture of hydrochloric acid with atmospheric air was heated in the presence of a suitable substance capable of initiating the interaction of these two gases by its affinity to both, it would to a very great extent be converted into chlorine with the simultaneous formation of steam, because the formation of steam from oxygen and hydrogen gives rise to the evolution of a considerably larger quantity of heat than the combination of hydrogen and chlorine. Mr. Deacon found that the salts of copper were a very suitable substance for this purpose, and took out a patent for this process in 1868. He intrusted the study of the theoretical and practical problems connected with this process to Dr. Ferdinand Hurter, who carried them out in a manner which will always remain memorable and will never be surpassed, as an example of the application of scientific methods to manufacturing problems, and which soon placed this beautiful and simple process on a sound basis as a manufacturing operation.

In the ordinary course of manufacture the major part—about two-thirds—of the hydrochloric acid is obtained mixed with air and a certain amount of steam, but otherwise very little contaminated. Instead of condensing the muriatic acid from this mixture of gases by bringing it into contact with water, Mr. Deacon passed it through a long series of cooling pipes to condense the steam, which of course absorbed hydrochloric acid, and formed a certain quantity of strong muriatic acid. The mixture of gases was then passed through an iron superheater to raise it to the required temperature, and thence through a mass of broken bricks impregnated with sulphate or chloride of copper contained in a chamber or cylinder called a decomposer, which was protected from loss of heat by being placed in a brick furnace kept sufficiently hot. In this apparatus from 50 to 60 per cent. of the hydrochloric acid in the mixture of gases was burnt to steam and chlorine. In order to separate this chlorine from the steam and the remaining hydrochloric acid the gases were washed with water, and subsequently with sulphuric acid. The mixture now consisted of nitrogen and oxygen, containing about 10 per cent. of chlorine gas, which could be utilized without any difficulty in the manufacture of bleach liquors and chlorate of potash, and which Mr. Deacon also succeeded in using for the manufacture of bleaching powder, by bringing it into contact in specially constructed chambers with large surfaces of hydrate of lime. Within recent years this latter object has been attained in a more expeditious and perfect manner by continuous mechanical apparatus (of which those constructed by Mr. Robert Hasenclever and Dr. Carl Langer have been the most successful), in which the hydrate of lime is transported in a continuous stream by single or double conveyors in an opposite direction to the current of dilute chlorine, and the bleaching powder formed delivered direct into casks, thereby avoiding the intensely disagreeable work of packing this offensive substance by hand.

ADVANTAGES OF THE DEACON PROCESS.

Mr. Deacon's beautiful and scientific process thus involves still less movement of materials than the very simple process of Mr. Weldon, because in lieu of large volumes of liquids he only moves a current of gas through his apparatus, which requires a minimum of energy. The only raw material used for converting hydrochloric acid into chlorine is atmospheric air, the cheapest of all at our command. The hydrochloric acid which has not been converted into chlorine by the process is all obtained, dissolved in water, as muriatic acid, and is not lost, as in previous processes, but is still available to be converted into chlorine by other methods, or to be used for other purposes.

In spite of these distinct advantages, this process took a long time before it became adopted as widely as it undoubtedly deserved. This was mainly due to the fact that the economy in the use of muriatic acid which it effected was at the time when the process was brought out, and for many years afterward, no object to the majority of chlorine manufacturers, who were still producing more of this commodity than they could use. Moreover, there were other reasons. The plant required for this process, although so simple in principle, is very bulky in proportion to the quantity of chlorine produced, and as I have pointed out, the process only succeeded in converting about one-third of the hydrochloric acid produced into chlorine, the remainder being obtained as muriatic acid, which had in most instances to be converted into chlorine by the Weldon process; so that the Deacon process did not constitute an entirely self-contained method for this manufacture. This defect, of small moment as long as muriatic acid was produced in excessive quantities, was only remedied by an invention of Mr. Robert Hasenclever, a short number of years ago; when by the rapid development of the ammonia soda process the previous existing state of things had been completely changed,

* Opening address by Dr. Ludwig Mond, F.R.S., President of the Chemistry Section, British Association for the Advancement of Science, and published in Pharmaceutical Journal.

and when, at least on the Continent, muriatic acid was no longer an abundant and valueless by-product, but, on the contrary, the alkali produced by the Le Blanc process had become a by-product of the manufacture of chlorine. Mr. Hasenclever, in order to make the whole of the muriatic acid he produces available for conversion into chlorine by the Deacon process, introduces the liquid muriatic acid in a continuous stream into hot sulphuric acid contained in a series of stone vessels, through which he passes a current of air. He thus obtains a mixture of hydrochloric acid and air, well adapted for the Deacon process, the water of the muriatic acid remaining with the sulphuric acid, from which it is subsequently eliminated by evaporation. In this way the chlorine in the hydrochloric acid can be almost entirely obtained in its free state by the simplest imaginable means, and with the intervention of no other chemical agent than atmospheric air. Since their introduction the Deacon process has supplanted the Weldon process in nearly all the largest chlorine works in France and Germany, and is now also making very rapid progress in this country.

THE WELDON-PECHINEY PROCESS.

Mr. Weldon, when he decided to give up his manganite of magnesia process, by no means relaxed his efforts to work out a chlorine process which should utilize the whole of the muriatic acid. While working with manganite of magnesia he found that magnesia alone would answer the purpose without the presence of the peroxide of manganese. He obtained the assistance of M. Pechiney, of Salindres, and in conjunction with him worked out what has become known as the "Weldon-Pechiney" process, which was first patented in 1884.

This process consists in neutralizing muriatic acid by magnesia, concentrating the solution to a point at which it does not yet give off any hydrochloric acid, and then mixing it into a fresh quantity of magnesia so as to obtain a solid oxychloride of magnesium. This is broken up into small pieces, which are heated up rapidly to a high temperature without contact with the heating medium, while a current of air is passing through them. The oxychloride of magnesium containing a large quantity of water, this treatment yields a mixture of chlorine and hydrochloric acid with air and steam, the same as the Deacon process, and this is treated in a very similar way to eliminate the steam and the acid from the chlorine. The acid condensed is, of course, treated with a fresh quantity of magnesia, so that the whole of the chlorine which it contains is gradually obtained in the free state.

The rapid heating to a high temperature of the oxychloride of magnesium without contact with the heating medium was an extremely difficult practical problem, which has been solved by M. Pechiney and his able assistant, M. Boulouvard, in a very ingenious and entirely novel way.

They lined a large wrought iron box with firebricks, and built inside of this vertical firebrick walls with small empty spaces between them, thus forming a number of very narrow chambers, so arranged that they could all be filled from the top of the box, and emptied from the bottom. These chambers they heated to a very high temperature by passing a gas flame through them, thus storing up in the brick walls enough heat to carry out and complete the decomposition of the magnesium oxychloride, with which the chamber was filled when hot enough.

Mr. Weldon himself called this apparatus a "baker's oven," in which trade certainly the same principle had been employed from time immemorial; but to my knowledge it had never before been used in any chemical industry. This process has been at work at M. Pechiney's large alkali works at Salindres, and is now at work in this country at the chlorate of potash works of Messrs. Allbright & Wilson, at Oldbury, a manufacture for which it offers special advantages. Mr. Weldon and M. Pechiney had expected that this process would become specially useful in connection with the ammonia soda process by preparing in the way proposed by Mr. Solvay and Mr. Weldon, in 1872, a solution of magnesium chloride as a by-product of this manufacture; but instead of obtaining muriatic acid from this solution by Clemm's process, to treat it by the new process, so as to obtain the bulk of the chlorine at once in the free state. But M. Pechiney did no more succeed than his predecessors in recovering the ammonia by means of magnesia in a satisfactory way.

Quite recently, however, it has been applied to obtain chlorine in connection with the ammonia soda process by Dr. Pick, of Czakowa, in Austria. He recovers the ammonia as usual, by means of lime, and converts the solution of chloride of calcium, obtained by a process patented by Mr. Weldon in 1869, viz., by treatment with magnesia and carbonic acid under pressure, into chloride of magnesium with the formation of carbonate of lime. The magnesium chloride solution is then concentrated and treated by the Weldon-Pechiney process.

CHLORINE IN THE AMMONIA SODA PROCESS.

I have repeatedly referred during this brief history to the great change which has been brought about in the position of chlorine manufacture by the development of the ammonia soda process, and have pointed out that the muriatic acid which for a long time was the by-product of the Le Blanc process, without value, thereby became gradually its main and most valuable product, while the alkali became its by-product.

I have told you how, very early in the history of this process, Mr. Solvay and Mr. Weldon proposed means to provide for this contingency, and how Mr. Weldon continued to improve these means until the time of his death. Mr. Solvay, on his part, also followed up the subject with that tenacity and sincerity of purpose which distinguishes him; his endeavors being mainly directed to producing chlorine direct from the chloride of calcium running away from his works by mixing it with clay and passing air through the mixture at very high temperatures, thus producing chlorine and a silicate of calcium, which could be utilized in cement making. The very high temperatures required prevented, however, this process from becoming a practical success.

I have already told you what a complicated series of operations Dr. Pick has lately resorted to in order to obtain the chlorine from this chloride of calcium. Yet the problem of obtaining chlorine as a by-product of the ammonia soda process presents itself as a very simple one.

This process produces a precipitate of bicarbonate of soda and a solution of chloride of ammonium by treating natural brine, or an artificially made solution of salt, in which a certain amount of ammonia has been dissolved, with carbonic acid. In their original patent of 1838, Messrs. Dyar and Hemming proposed to evaporate this solution of ammonium chloride, and to distill the resulting dry product with lime to recover the ammonia. Now, all that seemed to be necessary to obtain the chlorine from this ammonium chloride was to substitute another oxide for lime in the distillation process, which would liberate the ammonia and form a chloride which, on treatment with atmospheric air, would give off its chlorine and reproduce the original oxide. The whole of the reactions for producing carbonate of soda and bleaching powder from salt would thus be reduced to their simplest possible form; the solution of salt, as we obtain it in the form of brine direct from the soil, would be treated with ammonia and carbonic acid to produce bicarbonate, and subsequently monocarbonate of soda; the limestone used for producing the carbonic acid would yield the lime required for absorbing the chlorine, and produce bleaching powder instead of being run into the rivers in combination with chlorine in the useless form of chloride of calcium; and both the ammonia (used as an intermediary in the production of soda) and the metallic oxide (used as an intermediary in the production of chlorine) would be continuously recovered.

The realization of this fascinating problem has occupied me for a great many years. In the laboratory I obtained soon almost theoretical results. A very large number of oxides and even of salts of weak acids were found to decompose ammonium chloride in the desired way; but the best results (as was to be clearly anticipated from thermo-chemical data) were given by oxide of nickel.

DIFFICULTIES OF THE NEW PROCESS.

When, however, I came to carry this process out on a large scale, I met with the most formidable difficulties, which it took many years to overcome successfully.

The very fact that ammonium chloride vapor forms so readily metallic chlorides when brought in contact at an elevated temperature with metals or oxides, or even silicates, led to the greatest difficulty, viz., that of constructing apparatus which would not be readily destroyed by it.

Among the metals we found that platinum and gold were the only ones not attacked at all. Antimony was but little attacked, and nickel resisted very well if not exposed to too high a temperature, so that it could be, and is being, used for such parts of the plant as are not directly exposed to heat. The other parts of the apparatus coming in contact with the ammonium chloride vapor, I ultimately succeeded in constructing of cast and wrought iron, lined with firebricks or Doulton tiles, the joints between these being made by means of a cement consisting of sulphate of baryta and waterglass.

After means had been devised for preventing the breaking of the joints through the unequal expansion of the iron and the earthenware, the plant so constructed has lasted very well.

Oxide of nickel, which had proved the most suitable material for the process in the laboratory, gave equally good chemical results on the large scale, but occasionally a small quantity of nickel chloride was volatilized through local overheating, which, however, was sufficient to gradually make up the chlorine conduits. We therefore looked out for an active material free from this objection. Theoretical considerations indicated magnesia as the next best substance, but it was found that the magnesium chloride formed was not anhydrous, but retained a certain amount of the steam formed by the reaction, which gave rise to the formation of a considerable quantity of hydrochloric acid on treatment with hot air. In conjunction with Dr. Eschellman (who carried out the experiments for me), I succeeded in reducing the quantity of this hydrochloric acid to a negligible amount by adding to the magnesia a certain amount of chloride of potassium, which probably has the effect of forming an anhydrous double chloride.

This mixture of magnesia and potassium chloride is, after the addition of a certain quantity of china clay, made into small pills in order to give a free and regular passage throughout their entire mass to the hot air and other gases with which they have to be treated. In order to avoid as far as possible the handling and consequent breaking of these pills, I vaporize the ammonium chloride in a special apparatus, and take the vapors through these pills and subsequently pass hot air through, and then again ammonium chloride vapor, and so on, without the pills changing their place.

VAPORIZATION OF THE AMMONIUM CHLORIDE.

The vaporization of the ammonium chloride is carried out in long cast iron retorts lined with thin Doulton tiles, and placed almost vertically in a furnace which is kept by producer gas at a very steady and regular temperature. These retorts are kept nearly full with ammonium chloride, so as to have as much active heating surface as possible. From time to time a charge of ammonium chloride is introduced through a hopper at the top of these retorts, which is closed by a nickel plug. The ammonium chloride used is very pure, being crystallized out from its solution as produced in the ammonia soda manufacture by a process patented by Mr. Gustav Jarmay, which consists in lowering the temperature of these solutions considerably below 0° C. by means of refrigerating machinery. The retorts will, therefore, evaporate a very large amount of ammonium chloride before it becomes necessary to take out through a door at their bottom the non-volatile impurities which accumulate in them. The ammonium chloride vapor is taken from these retorts by cast iron pipes lined with tiles and placed in a brick channel, in which they are kept hot, to prevent the solidification of the vapor, to large upright wrought iron cylinders which are lined with a considerable thickness of firebricks, and are filled with the magnesia pills, which are, from the previous operations, left at a temperature of about 300° C. On its passage through the pills the chlorine in the vapors is completely retained by them, the ammonia and water vapor formed pass on and are taken to a suitable condensing apparatus. The reaction of the ammonium chloride vapor upon magnesia being exo-thermic, the temperature of the pills rises during this operation, and no addition of heat is necessary to complete it. The temperature, however, does not rise sufficiently to satisfactorily complete the second operation, viz., the liberation of the chlorine and the reconversion of the magnesium chloride into magnesium oxide by means of air. This reaction is slightly endo-thermic, and thus absorbs a small amount of heat, which has to be provided in one way or another. I effect this by heating the pills to a somewhat higher temperature than is required for the action of the air upon them, viz., to 600° C., by passing through them a current of a dry inert gas free from oxygen heated by a Siemens-Cowper stove to the required temperature. I use for this purpose the gas leaving the carbonating plant of the ammonia soda process.

This current of gas also carries out of the apparatus the small amount of ammonia which was left in between the pills. It is washed to absorb this ammonia, and after washing, this same gas is passed again through the Siemens-Cowper stove, and thus constantly circulated through the apparatus, taking up the heat from the stove and transferring it to the pills. When these have attained the required temperature, the hot inert gas is stopped and a current of hot air passed through, which has also been heated to 600° C. in a similar stove. The air acts rapidly upon the magnesium chloride, and leaves the apparatus charged with eighteen to twenty per cent. of chlorine and a small amount of hydrochloric acid. The chlorine comes gradually down, and when it has reached about three per cent. the temperature of the air entering the apparatus is lowered to 350° C. by the admixture of cold air to the hot air from the stove; and the weak chlorine leaving the apparatus is passed through a second stove, in which its temperature is raised again to 600° C., and passed into another cylinder full of pills which are just ready to receive the hot air current. A series of four cylinders is required to procure the necessary continuity for the process.

The chlorine gas is washed with a strong solution of chloride of calcium, which completely retains all the hydrochloric acid, and is then absorbed in an apparatus invented by Dr. Carl Langer, by hydrate of lime, which is made to pass by a series of interlocked transporting twin-screws in an opposite direction to the current of gas, and produces very good and strong bleaching powder, in spite of the varying strength of the chlorine gas. The hydrochloric acid absorbed by the solution of calcium chloride can, by heating this solution, be readily driven out and collected.

This process has now been in operation on a considerable scale at our works at Winnington for several years, with constantly improving results, notably with regard to the loss of ammonia, which has gradually been reduced to a small amount. The process has fully attained my object, viz., to enable the ammonia soda process to compete, not only in the production of carbonate of soda, but also in the production of bleaching powder, with the Le Blanc process.

PRODUCTION OF CHLORINE BY ELECTROLYSIS.

Nevertheless, I have hesitated to extend this process as rapidly as I should otherwise have done, because very shortly after I had overcome all its difficulties, entirely different methods from those hitherto employed for the manufacture of chlorine were actively pushed forward in different parts of the globe, for which great advantages were claimed, but the real importance and capabilities of which were and are up to this date very difficult to judge. I refer to the processes for producing chlorine by electrolysis.

During the first decade of this century, Humphry Davy had by innumerable experiments established all the leading facts concerning the decomposing action of an electric current upon chemical compounds. Among these he was the first to discover that solutions of alkaline chlorides, when submitted to the action of a current, yield chlorine. His successor at the Royal Institution, Michael Faraday, worked out and proved the fundamental law of electrolysis, known to everybody as "Faraday's law," which has enabled us to calculate exactly the amount of current required to produce by electrolysis any definite quantity of chlorine. Naturally, since these two eminent men had so clearly shown the way, numerous inventors have endeavored to work out processes based on these principles for the production of chlorine on a manufacturing scale, but only during the last few years have these met with any measure of success.

It has taken all this time for the classical work of Faraday on electro-magnetism to develop into the modern magneto-electric machine, capable of producing electricity in sufficient quantity to make it available for chemical operations on a large scale; for you must keep in mind that an electric installation sufficient to light a large town will only produce a very moderate quantity of chemicals.

In applying electricity to the production of chlorine, various ways have been followed, both as to the raw materials and as to the apparatus employed. While most inventors have proposed to electrolyze a solution of chloride of sodium, and to produce thereby chlorine and caustic soda, I am not aware that up to this day any quantity of caustic soda made by electrolysis has been put on the market.

Only two electrolytic works producing chlorine on a really large scale are in operation to-day. Both electrolyze chloride of potassium, producing as a by-product caustic potash, which is of very much higher value than caustic soda, and of which a larger quantity is obtained for the same amount of current expended. These works are situated in the neighborhood of Stassfurt, the important center of the chloride of potassium manufacture. The details of the plant they employ are kept secret, but it is known that they use cells with porous diaphragms of special construction, for which great durability is claimed. There are at this moment a considerable number of smaller works in existence or in course of erection in various countries, intended to carry into practice the production of chlorine by electrolysis by numerous methods, differing mainly in the details of the cells to be used; but some of them also involving what may be called new principles. The most interesting of these are the processes in which

mercury is used alternately as cathode and anode, and salt as electrolyte. They aim at obtaining in the first instance chlorine and an amalgam of sodium, and subsequently converting the latter into caustic soda by contact with water, which certainly has the advantage of producing a very pure solution of caustic soda. Mr. Hamilton Castner has carried out this idea most successfully by a very beautiful decomposing cell, which is divided into various compartments, and so arranged that by slightly rocking the cell the mercury charged with sodium in one compartment passes into another, where it gives up the sodium to water, and then returns to the first compartment, to be recharged with sodium. His process has been at work on a small scale for some time at Oldbury, near Birmingham, and works for carrying it out on a large scale are now being erected on the banks of the Mersey, and also in Germany and America.

Entirely different from the foregoing, but still belonging to our subject, are methods which propose to electrolyze the chlorides of heavy metals (zinc, lead, copper, etc.) obtained in metallurgical operations or specially prepared for this purpose, among which the processes of Dr. Carl Hoepfner deserve special attention. They eliminate from the electrolyte immediately both the products of the electrolysis, chlorine on one side and zinc and copper on the other, and thus avoid all secondary reactions, which have been the great difficulty in the electrolysis of alkaline chlorides.

All these processes have, however, still to stand the test of time before a final opinion can be arrived at as to the effect they will have upon the manufacture of chlorine, the history of which we have been following, and this must be my excuse for not going into further details. I have endeavored to give you a brief history of the past of the manufacture of chlorine, but I will to-day not attempt to deal with its future. Yet I cannot leave my subject without stating the remarkable fact that every one of these processes which I have described to you is still at work to this day, even those of Scheele and Berthollet, all finding a sphere of usefulness under the widely varying conditions under which the manufacture of chlorine is carried on in different parts of the world.

CONCLUSION.

Let me express a hope that a hundred years hence the same will be said of the processes now emerging and the processes still to spring out of the inventor's mind. Rapid and varied as has been the development of this manufacture, I cannot suppose that its progress is near its end, and that nature has revealed to us all her secrets as to how to procure chlorine with the least expenditure of trouble and energy. I do not believe that industrial chemistry will in future be diverted from this section and have to wander to section A under the ægis of applied electricity. I do not believe that the easiest way of effecting chemical changes will ultimately be found in transforming heat and chemical affinity into electricity, tearing up chemical compounds by this powerful medium and then to recombine their constituents in such form as we may require them. I am sure there is plenty of scope for the manufacturing chemist to solve the problems before him by purely chemical means, of some of which we may as little dream to-day as a few years ago it could have been imagined that nickel would be extracted from its ores by means of carbon monoxide.

At a meeting of this Association which brings before us an entirely new form of energy—the Roentgen rays—which have enabled us to see through doors and walls and look inside the human body, which brings before us a new form of matter, represented by argon and helium, which, as their discoverers, Lord Rayleigh and Prof. Ramsay, have now abundantly proved, are certainly elementary bodies, inasmuch as they cannot be split up further, but are not chemical elements, as they possess no chemical affinity and do not enter into combinations—at a meeting at which such astounding and unexpected secrets of nature are revealed to us, who would call in doubt that, notwithstanding the immense progress pure and applied science have made during this century, new and greater and farther reaching discoveries are still in store for ages to come?

HOW TO CLEANSE, WASH OR DYE LACES.

To wash lace curtains, says the Boston Journal of Commerce, put them in a tub of warm water, squeeze and press them, changing the water several times, until the water is nearly clear, then use hot water and rub with soap. Do not rub the curtains, but squeeze and press them until clean; then boil them in clean soapy water, adding a teaspoonful or less of powdered borax to the scalding water. After boiling five or ten minutes, lift out carefully and rinse. The curtains may be put through a wringer, but should not be wrung by hand, except to squeeze them out carefully so as not to tear them. Make the rinse water quite blue and starch stiffly. Hang them evenly across the line, being careful to pull out the edges all around and stretch the curtains squarely, as after they are dry it is difficult to change their shape. Take them from the line before they are quite dry, and roll up ready to iron, being careful in ironing not to run the point of the iron through the meshes of the lace.

To clean lace veils: Soap them well, and lay them for twenty-four hours in just enough water to cover. If much discolored, change the water at expiration of that period and let them soak again, then rinse; immerse in weak starch water, prick out as evenly as possible, roll in a towel till nearly dry, then press with a warm iron.

To dye lace cream color: Put yellow ocher into a muslin bag and pour boiling water over it. Any shade desired may be obtained by adding water or ocher to lighten or darken. Strong coffee also dyes very nicely. Soak black lace in a basin filled with tea or beer, or soak it in sal volatile and water, then rinse in cold water. Make some thin starch and dip the lace into it, and while still damp pull out and iron carefully between the folds of a handkerchief. The latest mode, however, is to clean with kerosene.

An easy way to clean lace: Spread the lace out carefully on wrapping paper, then sprinkle it carefully with calcined magnesia; place another paper over it and put it away between the leaves of a book for two or three days. All it needs is a skillful shake to scatter the white powder and then it is ready for wear, with slender threads intact and as fresh as when new.

Laces not in wear should be dabbled in clear, cold water to remove all trace of starch; dried in the sun and wrapped in dark blue paper.

PASTES AND MUCILAGES.

By W. G. SCOTT.

LABEL GUM—FOR PAPER TO GLASS.

(a)	Pulverized gum arabic	4 oz.
	Boiling water	6 fl. oz.
(b)	Glycerine	2 "

Dissolve (a), then add (b).

NEW "TIN CAN" LABEL PASTE—FOR PAINT AND VARNISH CANS.

(a)	Brown sugar	2 lb.
	Boiling water	16 fl. oz.
(b)	French gelatine	½ oz.
	Water	4 fl. oz.
(c)	Corn starch	12 oz.
Beat up with		
	Cold water	12 fl. oz.
And pour the batter into		
	Boiling water	32 "

Continue boiling (c), if necessary, until the paste is translucent. Dissolve (a) and (b) separately, and then mix with (c). Paste for tin should not be too thin, and the tin should be free from grease. New tin generally has an oily or greasy surface, due to the tallow or oil used in the plating process. The grease may be removed with an alkali or with benzine, but in a factory where much labeling is done it is better to slightly roughen the surface of the tin where the label is to be placed with a piece of fine sandpaper, No. 0. This paste is very adhesive, and labels pasted with it will adhere nicely, even in a damp place. The sugar in its composition also renders it proof against cracking when exposed to a dry atmosphere.

PAPER PASTE—TO ADHERE TO METAL.

(a)	Pulverized gum tragacanth	1 oz.
	Pulverized gum arabic	4 "
	Cold water	20 fl. oz.
(b)	Glycerine	4 "
	Thymol	80 grains.
(c)	Boiling water	12 fl. oz.

MUCIS GUM—OR PASTE FOR TISSUE PAPER.

(a)	Pulverized gum arabic	2 oz.
	White sugar	½ "
	Boiling water	3 fl. oz.
(b)	Common laundry starch	1½ oz.
	Cold water	3 fl. oz.
Make into a batter and pour into		
	Boiling water	32 "

Mix (a) with (b), and keep in a wide mouthed bottle.

PERFECT PAPER PASTE—FOR PAPER ONLY.

(a)	Powdered gum tragacanth	1 oz.
	Boiling water	8 fl. oz.
(b)	Pulverized gum arabic	1 oz.
	Salicylic acid	⅛ "
	Boiling water	2 fl. oz.
(c)	Wheat flour	2 oz.
	White dextrine	½ "
	Cold water	2 fl. oz.
Make into a batter and pour into		
	Boiling water	12 "

Mix (a) with (b), then add (c); finally add ¼ oz. glycerine, to which has been added 8 drops oil of lavender. This is a good preparation, but is rather complicated, and too much work to make up.

PARCHMENT PASTE—FOR HEAVY PAPER.

(a)	Pulverized rice	2 oz.
	Boiling water	12 fl. oz.
(b)	Pulverized gum arabic	2 oz.
	Boiling water	4 fl. oz.
(c)	White sugar	1 oz.
	Salicylic acid	16 grains.
	Boiling water	1 fl. oz.

Boil (a) for about half an hour, let cool somewhat, strain, and then stir in (b) and (c). This paste is from an old English recipe, and is a nice article; but, like the preceding, it is too much trouble taken for the result obtained.

TRAGACANTH MUCILAGE—FOR PAPER.

(a)	Pulverized tragacanth	1 oz.
	Glycerine	4 fl. oz.
(b)	Boiling water	16 "

Macerate the tragacanth with the glycerine in a glass mortar, then stir the paste into the boiling water. This makes a very thick mucilage; 32 fl. oz. of boiling water gives a medium, and 64 fl. oz. a thin paste. Tragacanth paste works very smooth, but is not very adhesive.

HOUSEHOLD MUCILAGE—FOR PAPER, ETC.

(a)	Pulverized gum arabic	3 oz.
	White sugar	1 "
	Boiling water	5 fl. oz.
(b)	White wine vinegar	1 "
	(or ¼ oz. acetic acid with ¾ oz. water).	

Mix (a) with (b). The acid is added to the gum in order to make it take hold of metal.

DEXTRINE MUCILAGE—FOR PAPER, ETC.

Yellow dextrine	4 oz.
Soft or distilled water	6 fl. oz.

Dissolve cold, as heat destroys the adhesive properties of dextrine. If a more fluid gum is desired, use 8 fl. oz. of water.

DEXTRO-ACACIA MUCILAGE—FOR PAPER PARCHMENT, ETC.

(a)	Yellow dextrine	4 oz.
	Cold water	8 fl. oz.
(b)	Pulverized gum arabic	4 oz.
	Boiling water	8 fl. oz.
(c)	Glycerine	2 "
	Oil of cinnamon	4 drops.

Dissolve each separately, then mix. This is a good article, and easy to prepare. It does not keep as well, however, as the borax mucilage, which is unalterable.

ANTISEPTIC PASTE (POISON)—FOR ORGANIC SPECIMENS.

(a)	Wheat flour	16 oz.
Beat to a batter with		
	Cold water	16 fl. oz.
Then pour into		
	Boiling water	32 "
(b)	Pulverized gum arabic	2 oz.
Dissolve in		
	Boiling water	4 fl. oz.
(c)	Pulverized alum	2 oz.
Dissolve in		
	Boiling water	4 fl. oz.
(d)	Acetate of lead	2 oz.
Dissolve in		
	Boiling water	4 fl. oz.
(e)	Corrosive sublimate	10 grains.

Mix (a) and (b) while hot, and continue to simmer; meanwhile stir in (c), and mix thoroughly, then add (d). Stir briskly, and empty in the dry corrosive sublimate. This paste is very poisonous. It is used for anatomical work, and for pasting organic tissue, labels on skeletons, etc.

GLUE PASTE—FOR CLOTH BOOKS, ETC.

(a)	White glue	4 oz.
	Cold water	8 fl. oz.

Soak glue four hours in the cold water, then dissolve in a glue pot.

(b)	Corn starch	4 oz.
	Cold water	8 fl. oz.
Mix, and pour into		
	Boiling water	16 "

Mix (a) with (b), and gently heat for about ten minutes. If wanted elastic, add 4 fl. oz. glycerine.

THYMOL DEXTRINE—FOR LABELS ON GLASS.

Yellow dextrine	8 oz.
Thymol	10 grains.
Dissolve in	
Cold or lukewarm water	18 fl. oz.

Boiling water should not be used with dextrine, as it impairs its adhesiveness.—The Western Painter.

THE TAPESTRY GARMENTS OF THE YNCAS.*

IN our reading of the story of days of old, amid the surge of wars, the growth of governments, the rise and fall of various dynasties, there now and again flit across the pages of the past figures of strange nations that are set like quaint emblazonments—all gold and color—to break the monotony of the text. These nations do not seem to belong to the every-day world at all, but rather to some region of romance, whence they issue, girt in a panoply of fascination, to captivate our imaginations, and to beguile us with a fairy tale of fact. Thus it was that the tale of the old Ynca civilization had come to bear almost the proportion of a legend when, some few years ago, it was restored to vivid reality by the discovery at Ancon, in Peru, of one of the old Ynca burial-places, wherein mummies of that forgotten people were found in abundance, and owing to the particularly dry nature of the soil, in an excellent state of preservation. In our present ignorance of Ynca "literature" (the method of keeping records by means of knotted threads of different colors and thicknesses would seem to present even more insuperable difficulties to the translator than are afforded by hieroglyphs) it is impossible to do more than guess at the age of the different interments; and, indeed, the chief interest of the find is not so much in the bodies themselves as in the wonderful tapestry robes with which a great number of these mummies were found to be adorned, and which show a wonderful knowledge both of the principles of design and of the various methods of weaving employed in their fabrication.

The mummies themselves present a very different appearance from the calm recumbent figures so familiar to visitors in the Egyptian department of the British Museum: they might almost be taken for a company of extremely fat pashas, sitting cross-legged and regarding the universe with an air of wide awake malevolence on their painted faces. That, however, is entirely the fault of their funeral "makeup;" the little shriveled body inside is of but small proportion when compared with its external appearance. It appears that the Yncas buried their dead—many of which are elaborately tattooed—in a sitting posture, with the knees drawn up to the chin and the arms tucked in against the body, something after the manner of a trussed fowl. Then came a tremendous padding of cotton and dead leaves, together with many of the implements that had been used during life, and all was finally sewed up in sacking and securely corded together. This represented the body of the mummy—a great square package resembling a bale of goods. On the top of this package was fixed a false head, the face painted red, the features simulated by strips of birch bark, the false hair and the head dress arranged according to the tribe or the rank in life that was to be indicated. When all was completed, more or less handsome tapestry garments were put as a covering over the sacking, and the richly bedight, outlandish looking figure was again banded about with the strong cords which were required to lower it into the earth. Delicately woven baskets, containing ornamental spindles, etc., were found with many of the bodies; and painted funeral tablets, having a form of design peculiar to them, were stuck beside them in the sand. If we could only read the inscriptions on these funeral tablets! On most of them the space is occupied with a crude representation of the human figure (not, let us hope, intended for a portrait of the deceased!) surrounded by symbols; but some of a different nature are woven of colored threads arranged on a frame, just like the wool and wire frames that may be seen in cottage homes in England at the present time.

The garments on which so much care in ornamentation has been lavished are nearly all of a type corresponding very closely with the poncho still common in South America, save that both the sides are sewn up, leaving only long slits for the arms. Generally two

* M. B. Hardie, in the Quiver.

pieces of stuff, woven to the exact size required, were joined in such a manner that the slit for the neck corresponded with the center seam; though in some of the more ornate fabrics, narrow strips of different patterns were sewed together horizontally to form the center, and a wide border would be joined down the sides to keep all firm. These ponchos, or uncus, as they were called, were very short, reaching about to the knees, and so extremely wide as to be able to cover the extended arms as far down as the hands. There is very little actual sewing visible about them, and what there is is so rude and coarse that we can readily credit the assertion that the Yncas, with all their elaborate weaving, were ignorant of the art of sewing as we understand it. From a quaint old author, himself the son of an Ynca princess, who published a book at Lisbon in 1609, "with license from the Holy Inquisition," many curious details relating to the habits and customs of his ancestors may be learned, which are fully brought out and exemplified by these same tapestries. When the Ynca women required to mend any garment, they stretched the frayed portion over the mouth of a pot large enough to surround the rent, and then setting warp and woof threads across it, they proceeded to weave in the lacking portion, so that in the end the garment was as good as new.

A MODEL ELECTRIC RAILWAY PLANT.

TROLLEY railways are now so common that it is taken as a matter of course that they are all pretty nearly alike, and that all that is necessary to constitute an electric railway is a source of current and cars provided with motors for using the current; but while the fundamental principles controlling the trolley systems of railways are the same on all roads of this description, there is a marked difference between the recent roads equipped with firstclass machinery and appurtenances and the earlier roads upon which the great problem of economical electric propulsion was worked out.

We present to our readers an illustrated description of a very complete plant located in New Haven, Conn., and belonging to the Fair Haven and Westville Railroad Company; in fact, the engines, machinery and general equipment of the road are so complete that we have ventured to call it a model trolley railroad.

We give a view of a portion of the road showing Westville, with West Rock in the distance, and an interior view of the power house, showing the engines, dynamos, and appurtenances. The power house is located on Mill River, in New Haven. Seven lines of railroad are operated from this station, employing 38 open cars, 42 closed cars and 3 sweepers. The combined length of the different branches is 25 miles. The power house is provided with three cross compound Allis engines, each having a stroke of 36 inches. The high pressure cylinders are 16 inches in diameter and the low pressure 30 inches. These engines are operated under a steam pressure of 120 pounds and make 92 revolutions a minute. The pressure in the receiver between high and low pressure cylinders is 8 pounds; consequently, the initial pressure in the low pressure cylinder is 8 pounds. The vacuum is 27 inches or 13 pounds.

Steam for these engines is generated by three vertical Manning boilers, another boiler of the same description being held in reserve with the fire banked, and there are also two additional reserve boilers, so that there are in all six boilers, which are rated at 160 horse power each.

With the crank shaft of each engine is directly connected a Westinghouse dynamo, having an armature 4 feet in diameter, with a capacity of 450 amperes at 500 volts. The dynamos are compound wound, and are connected with each other by an equalizing conductor to check any tendency of one dynamo to run as a motor by the current from the other.

Fig. 4 shows the arrangement of the dynamos, connections, switches and ampere meters at the power house. Only dynamos 1 and 2, which are supposed to be in active operation, are here represented. A represents the positive main conductor and A′ the negative, while E E are the equalizing conductors from the two dynamos, the positive and negative conductors being designated by the usual signs + and −. The positive and negative conductors of dynamo 2 lead to the switch, B, and connection is made by this switch with the con-

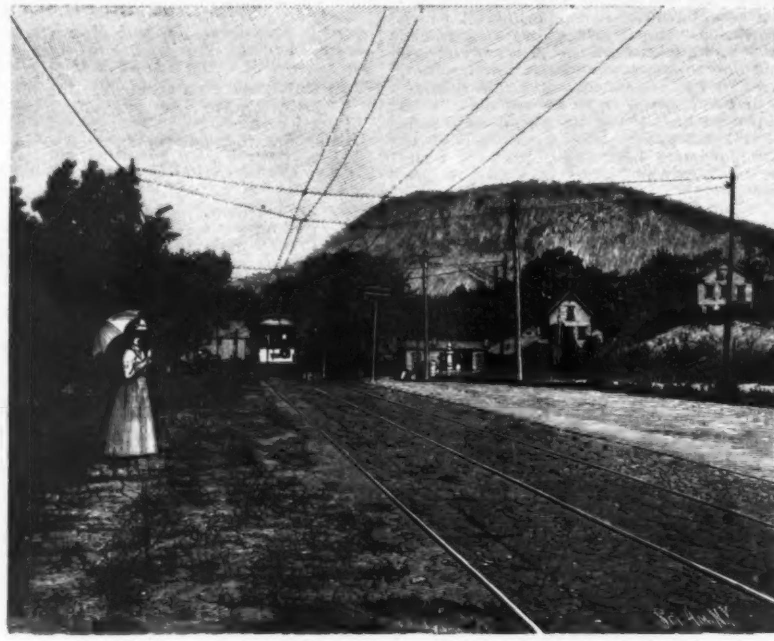


FIG. 1.—FAIR HAVEN AND WESTVILLE ROAD.

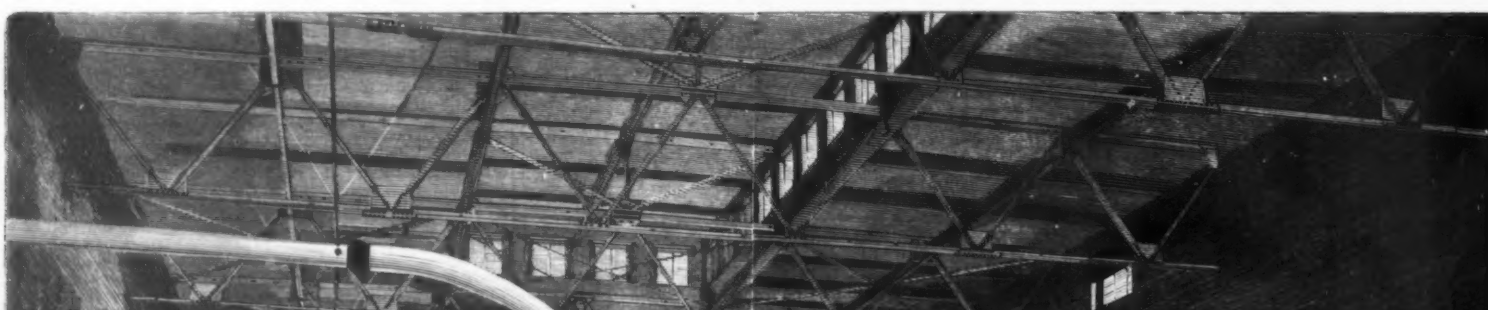


FIG. 2.—FAIR HAVEN AND WESTVILLE ELECTRIC RAILROAD—INTERIOR OF POWER HOUSE.

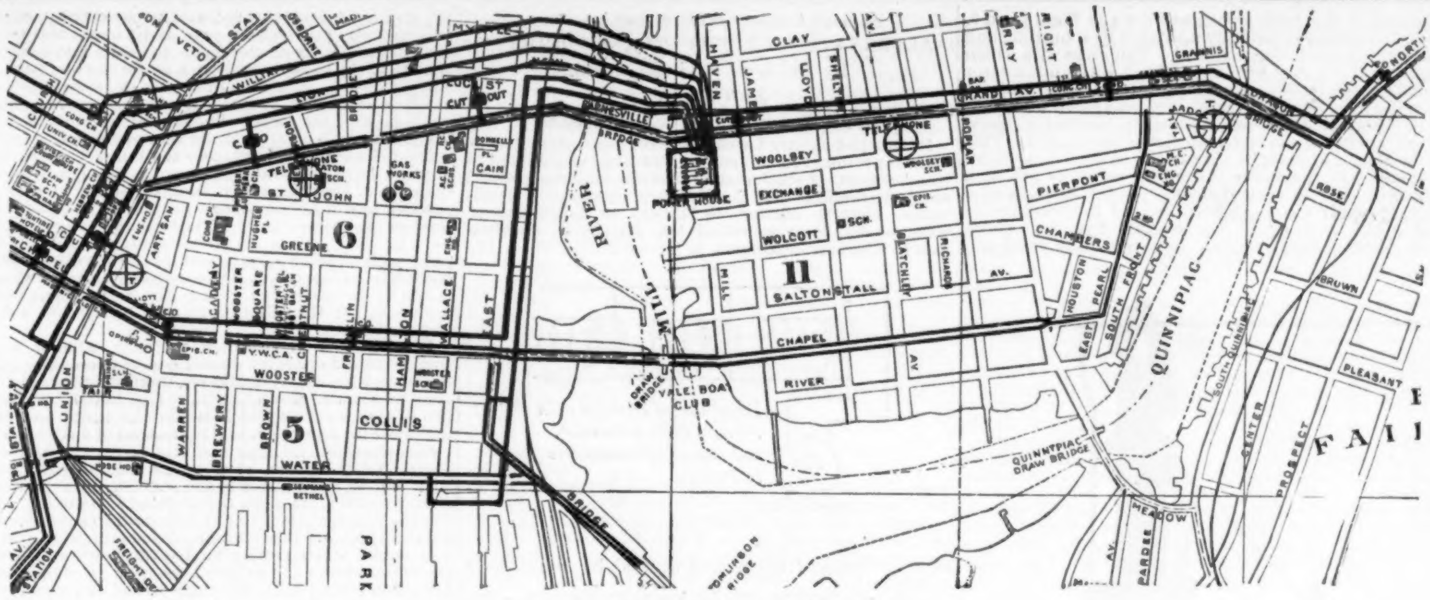


FIG. 3.—BRANCHES OF THE ROAD.

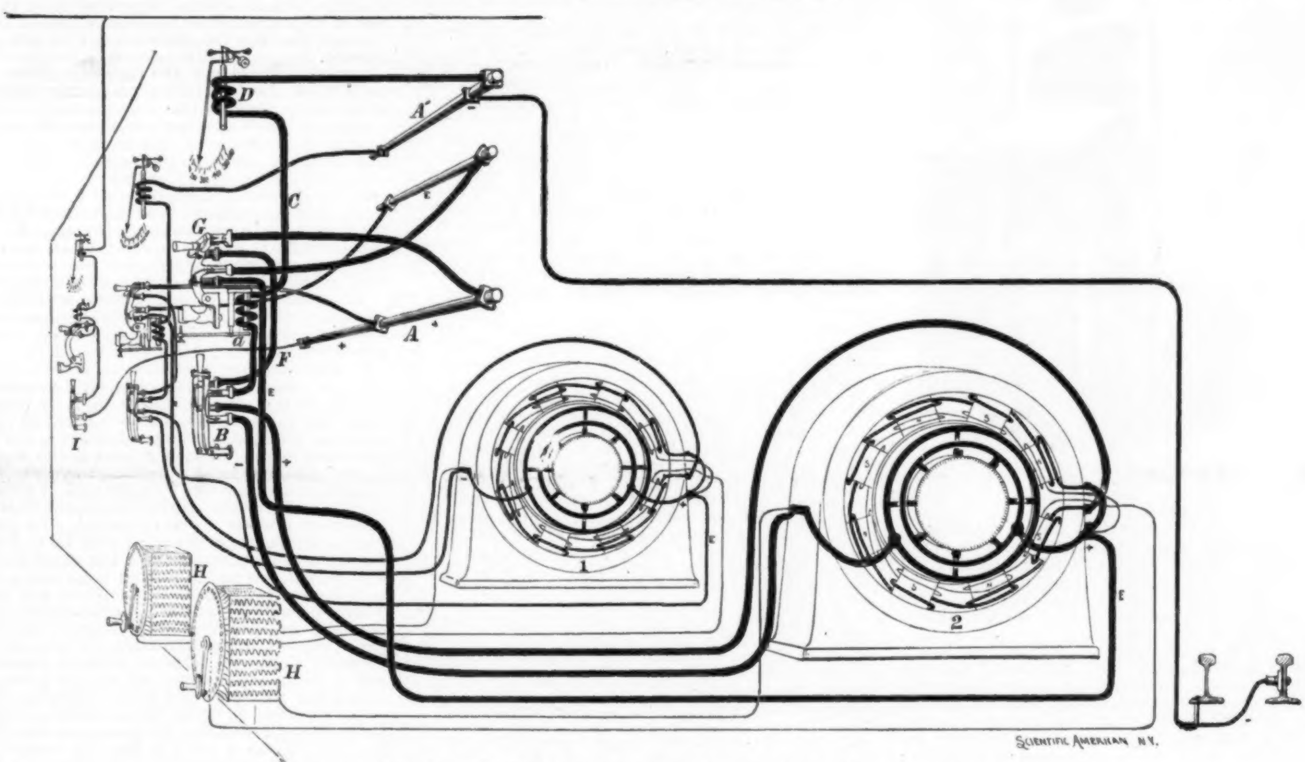


FIG. 4.—DIAGRAM OF DYNAMOS AND CONNECTIONS OF POWER HOUSE.

ductor, C, which connects with the main conductor through the ampere meter, D. The positive conductor from the dynamo is also connected with the main conductor by the conductor, F, through the circuit breaker, G.

The conductor, C, includes the electro-magnet, a, which controls the automatic releasing mechanism of the circuit breaker, G, so that when there is a cross or short circuit upon the line, the switch, G, is automatically released and the dynamos are thereby protected from injury. Two switches, two circuit breakers, and two ampere meters are here shown, one of each for each dynamo. The dynamos are each provided with a resistance box, H, which is connected up in the shunt circuit of the field magnet and is used to regulate the voltage in starting the dynamo. The dynamo is started with the switch, B, open, and when the required voltage has been reached, the switch, B, is closed, thereby throwing the current into the main conductors, A, A'. Should the load increase so that the action is below the normal in either of the dynamos, the deficiency in the series winding of the field magnet is supplied by the equalizing conductor, E, thereby bringing the voltage up and preventing one dynamo from acting against the other.

At I, in Fig. 4, is represented a panel having switches by means of which the particular branch of the road connected with the panel may be thrown into or out of the circuit. Each branch of the road has such a panel in the power station.

The trolley wire, T, is connected with the positive conductor at the power station, and the rails are connected with the negative conductor at the power station. To insure continuity of the return conductor, a wire cable usually extends under ground to the power station and is connected with each rail. At the power station the rails are connected with the main conductor by a cable, as shown in Fig. 5, the flange soldered to the end of the cable being clamped to the rail web by bolts. A lead plate is interposed between the flange and the rail to make the joint watertight, thereby obviating electrolytic action in the joint itself, and thus preventing corrosion. The trolley wire is suspended above the center of the track by a cross wire supported at either end by a small windlass in the end of a curved arm pivoted in a hood

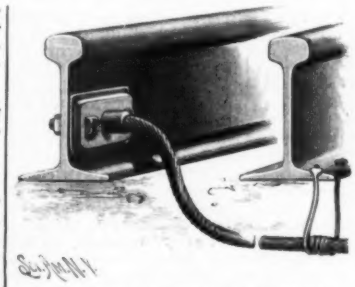


FIG. 5.—RAIL CONNECTIONS.

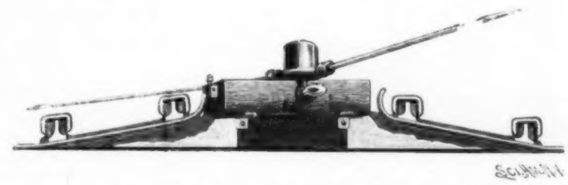


FIG. 8.—WIRE SUPPORT AT THE ENDS OF ADJACENT SECTIONS.

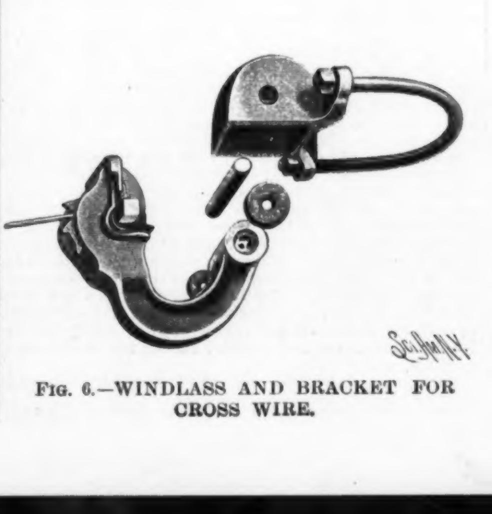


FIG. 6.—WINDLASS AND BRACKET FOR CROSS WIRE.

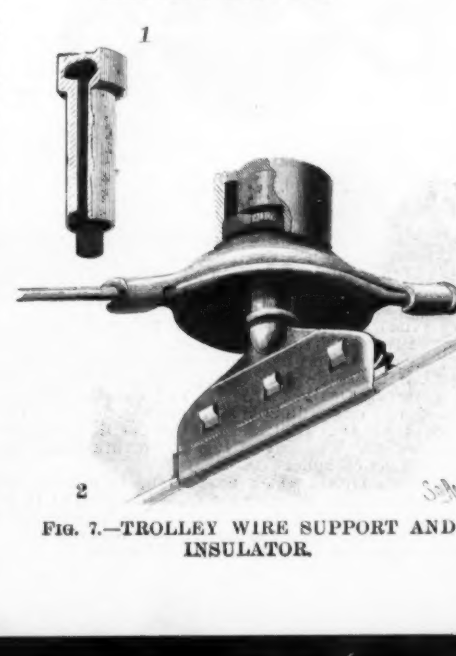


FIG. 7.—TROLLEY WIRE SUPPORT AND INSULATOR.

clamped to the trolley pole, as shown in Figs. 6 and 9. The curved arm is carefully insulated by a bushing and washers of insulating material. The cross wire which supports the trolley wire is provided with an insulator by which the trolley wire is suspended. This insulator is in the form of an inverted cup, as shown in Fig. 7, with a central aperture in which is inserted a screw covered with insulating material as shown at 1. This screw is held in place by a screw cap as shown in the engraving. On the lower end of the screw is placed a cross arm, having several hooks. A folded and perforated piece of metal is placed around the trolley wire and on the hooks projecting from the cross arm, and a long, narrow key is driven in between the cross arm

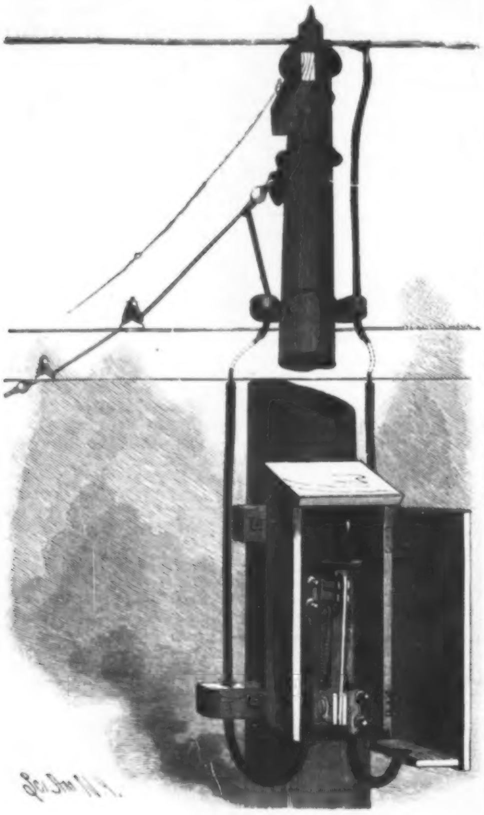


FIG. 9.—CUT-OUT.

and the trolley wire, bringing the folded piece of metal into firm engagement with the hooks and clamping the trolley wire. The narrow key has its smaller end split, with the upper part thereof bent up against the end of the cross arm to hold the key in place. This form of trolley wire suspension is very readily applied and easily removed and repaired.

The trolley wire at the ends of different sections is supported as shown in Fig. 8, the ends being clamped to a double wedge of insulating material, the lower edge of the wedge serving to form a bridge between the two ends of the trolley wire, which allows the trolley to pass smoothly over the break. The connection between two adjacent sections of the wire is completed or broken by means of a cut-out, shown in Fig. 9. This cut-out is secured to a trolley pole in such a position as to be accessible to linemen or other authorized persons, so that should anything occur on one section of the road which requires it to be cut out, the section may be rendered "dead" electrically by swinging out the arm of the cut-out.

An insulator which is inserted in the wires where the circuit is to be interrupted, and for connecting conductors with their supports, is shown in Fig. 10. This insulator consists of two parts, one formed of a rod having an eye on one end and a button on the other, and

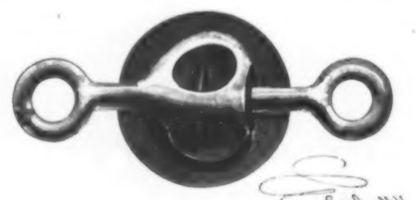


FIG. 10.—INSULATOR.

another rod having an eye upon one and a skeleton socket upon the other, the button of one part being inserted in the skeleton socket of the other part without electrical contact, the socket being filled and enveloped with insulating material as shown.

This road, which was organized in 1860, was equipped electrically in the summer of 1894. Since January 1, 1895, the current has been on continuously, there having been no shut-down during the operating hours since starting October 15, 1894. The speed of the cars is limited by city ordinance to 10 miles per hour within a mile of the City Hall and 12 miles per hour beyond that distance. The cost of fuel for operating the road is \$0·0045 per car mile.

For the courtesy which enabled us to procure the information here presented we are indebted to H. S. Parmlee, president of the company. We have reserved our description of the cars, the motors, and the wiring and operating of the cars for a future article.

[Continued from SUPPLEMENT, No. 1088, page 17395.]

ALTERNATE CURRENT TRANSFORMERS.*

By Dr. J. A. FLEMING, F.R.S.

LECTURE IV.

THE EMPLOYMENT OF TRANSFORMERS.

IN this last lecture I wish to direct your attention to certain problems in connection with the employment of transformers. I shall assume that the majority present are quite familiar with the ordinary methods of distributing electric current by means of transformers, whether by what is called the system of distribution by house transformers, as shown in Fig. 47, or the

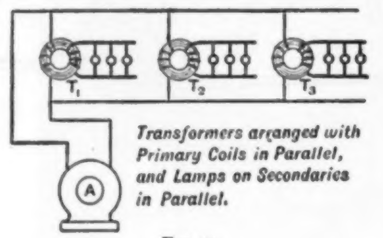


FIG 47.

more modern and economical method by transformer substations.

Generally speaking, the method of transformer distribution which is now found to be most practically useful in provincial towns and over large areas is somewhat as follows:

In the generating station the alternators either send their current into one common set of omnibus bars, the alternators working in parallel, from which bars a distribution is made by high tension feeds to various transformer substations, often a more complicated switchboard is employed in which the high tension feeders coming from the various transformer substations can be connected at pleasure to any alternator, or grouped together in any way on one or more of the alternators. It would be foreign to our subject here, at the present moment, to enter at all into the question of the parallel working alternators. It has been fully discussed in the technical journals and other publications. The high tension feeders are generally arranged to convey a high tension current at a pressure of 2,000 volts to certain transformer substations in which are placed a bank of transformers.

These transformers take their primary current through primary switches and fuses from primary omnibus bars connected to the feeders, and the secondary circuits of the transformers are generally arranged to feed a three wire system of low tension distribution. For this purpose each transformer is provided with three secondary terminals, and from the substation proceeds a three wire low tension system which is fed by one or more of the transformers, and to which the consumers are connected. In joining up a bank of transformers in this manner it is important that each of the transformers should have an equal percentage secondary drop for the same fraction of full load. Otherwise, if one transformer has a smaller secondary drop than another, that transformer with the least secondary drop will take the greatest share of the load, as the substation is loaded up, and it may, therefore, get overloaded and get very hot, and such an inequality of load tends to increase the more the bank of transformers is loaded up. It is always advisable to examine transformers in this manner, and if any transformer is found to have too large a secondary drop, then to remedy it by adding one or more turns to the secondary circuit. In addition to a low tension distribution from transformer substations, it is sometimes found convenient to run one or more high tension feeders to supply the outlying regions of the district which is then served with a system of house transformers.

The plan which I have found convenient to adopt in developing an alternating current station in a provincial town in which there is a central shop district in which the lighting is rather dense, and an outlying residential district in which it is rather scattered, is to arrange one or more low pressure secondary networks on the three wire system in the central portion of the town. Each of these networks is fed from a single transformer substation, and the secondary circuit forms a complete ring main, which is fed into by secondary feeders at three or four places. The transformer substations are interconnected by a high pressure connecting main, which serves in case of breakdown at one station to allow the duty of that station to be taken up by another substation. It is not advisable, in my opinion, to connect together the different separate secondary networks. One great advantage of the alternating current system is that it enables us, by having small separate secondary distribution systems perfectly insulated from one another, to limit the effect of a dead earth on one of these secondary networks, and that is an advantage which cannot be obtained on the ordinary low pressure system where the distribution network is connected throughout.

As regards the description of cable to be employed, it is now well understood that concentric cable forms in all cases the most satisfactory cable, both for the high pressure and the low pressure conductors. By the employment of concentric cable we eliminate at once any difficulties which would arise due to induction taking place on neighboring telegraph and telephone wires; and we also largely reduce the inductive drop in pressure which would otherwise exist if the three members of the secondary circuit were separate cables separated by any distance from one another. My own experience is that the secondary network is best laid down by means of triple concentric cable, and there are certain advantages in making the outer member of this cable the middle wire of the three conductor system. In any case, the house connections are quite easily made. It is also desirable to get rid altogether of distribution boxes and service boxes, which become localities in which coal gas can collect and occasionally explode.

In laying down the secondary distribution system by means of lead covered and armored triple concentric cable, by far the best plan is to make the proper connection with a service main to each house at the time that the cable is laid, and to have this joint entirely sealed up in lead, making use of no junction box at all, or at most of a right angle iron sleeve to mechanically protect the joint. The service main can then be taken into each shop or house and connected up to the consumer's terminals, whether the building takes light or not. In the central portions of a town it is only a question of time for every shop or house to take the current, and it saves expense ultimately to make this joint in the first instance. The secondary cable, having been laid in this manner, should be tested, and my own practice is to insist upon a test of 1,000 volts between the different members of the secondary circuit when it is laid in the earth, but before the house connections are made. If the cable stands this test, it has a large factor of safety.

With regard to the high pressure cable, it is customary to use ordinary duplex concentric cable, and if the service is a 2,000 volt service, then, after the cable has been laid in the ground, it should be tested by a pressure of 4,000 volts placed between the inner and outer members for one hour, and a pressure of 2,000 volts between the outer member and the earth, and the cable should not be accepted unless it has passed this test. As it is always desirable to use concentric cables in connection with all modern transformer systems of distribution, it is necessary to pay attention to some peculiar effects which are observed in connection with concentric cables when supplying transformers, and during the remainder of the lecture I propose to occupy your attention chiefly with practical points connected with these effects. They may be divided into four classes. There are first those which may be called the resistance effects, which are effects connected with the distribution of the current over the cross section of the conductor employed for the transmission of the alternating current.

Secondly, there are the capacity effects, which depend upon the fact that a concentric cable is a large condenser or Leyden jar.

Thirdly, there are the resonance effects, which are due to the reaction of this capacity upon the alternators or the primary transformers.

Fourthly, there are effects which may be called the initial stage effects, depending upon the capacity of the cable, and the inductance of the transformers supplied through it, both of which co-operate together to produce peculiar effects at the moment when the cable carrying the transformers is switched into connection either with another live cable or with an alternator.

We shall consider each of these in turn. It will be necessary to preface a detailed discussion of these effects by some general remarks upon the nature of current flow in inductive circuits. Every electric circuit which has self-induction or inductance and capacity has a natural period of electric vibration—that is to say, if the electric charge in it is disturbed, and then left to itself, it oscillates backward and forward as water would do in a long tube having the ends closed by elastic caps. In such a case, if the water was disturbed and then left to itself, it would oscillate to and fro in virtue of the fact that the mass of water possesses inertia, and that the elastic caps on the ends of the pipe permit the water to be displaced. In other words, such a closed pipe has what may be called hydraulic inertia and permittance. In the same manner, a circuit which has self induction possesses what may be called electric inertia or inductance, and a condenser which permits of electric displacement to be made through its dielectric or non-conductor has what is called capacity or permittance. If a condenser with a capacity, C, is being charged through a resistance, having a value represented by R, the product, C R, is called the time constant of that system, and it represents the time in which the charged condenser, if left to itself, short-circuited by the resistance, R, would fall in potential to a certain fraction (very nearly two-thirds of its original potential); again, if L is the inductance of a conductor, and R is its resistance, then $\frac{L}{R}$ is called the time constant of that circuit, and this is the time in which a current in that circuit would rise to about two-thirds of its full value if a constant electromotive force is put upon the ends of the inductive resistance. The first product, C R, is called the electrostatic time constant of the condenser and resistance, and the quotient, $\frac{L}{R}$, is called the electromagnetic time constant of the inductive resistance. If, then, we join in series a condenser having a capacity or permittance, C, and an inductive resistance having an inductance, L, and a resistance, R, it can be shown that the complete, free, periodic time of oscillation of a charge of electricity in that system is given by this expression:

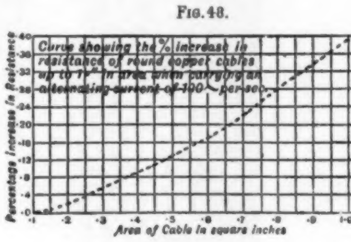
$$t = 2\pi\sqrt{\frac{L}{R}CR}.$$

In other words, the complete periodic time is equal to 2π times the geometric mean of the electrostatic and electromagnetic time constants. It must be noted that this is the time of oscillation of the charge when left to itself, but it is of course perfectly possible to make what is called a forced oscillation, and that is what is done in every transformer system. These electrical quantities have their mechanical analogues. Suppose, for instance, we take a pliable lath with a weight on it and fix it at one end, the pliability of the lath is the analogue of the capacity of the electrical system, the mass of the weight on the end is the mechanical analogue of the inductance of the system. If then we displace the lath or bend it and leave it to itself, it vibrates to and fro with a natural period of its own, in virtue of the fact that the system has pliability or permittance and mass or inductance. If the mass be small and the pliability is small, the time of vibration is small, but if the pliability is great and the mass is great, then the time of vibration is great. Such a loaded flexible rod not only has a free period of vibration of its own if fixed at one end and set in oscillation, but we may give it a forced oscillation. Before explaining the manner in which certain electrical effects may be mechanically imitated by such a loaded lath,

* Lecture before the Society of Arts.—From the Journal of the Society.

we will consider a little more in detail the properties of concentric cables when used with alternating currents. In the first place, a cable intended for use with an alternating current must not have the metal or conductor of which it is made of a thickness exceeding a certain value, for the reason that a certain time has to elapse before the current is established in the central portions of the conductor, and, therefore, if the conductor is used with alternating currents, its actual resistance depends upon the frequency and the thickness of the conductor. Without going into more elaborate explanations on this point, for which I refer the reader to other text books, I may give here a table showing the resistance of high conductivity round copper conductors to continuous and alternating currents of a certain frequency, the results of which are set out graphically in a curve in Fig. 48.

FIG. 48.



The following table shows us that practically the largest conductor which should be used in connection with alternating current work is a cable having an outside diameter equal to a 19/12 cable, and that if the cable has a greater diameter, then its resistance to alternating currents of a frequency 100 is sensibly different from its resistance to continuous currents. In the next place, with regard to capacity, suppose that a concentric cable is formed by putting one cylindrical tube in the interior of another cylindrical tube, the space between the tubes being occupied by a non-conducting material or dielectric having a specific inductive ca-

TABLE OF RESISTANCE OF HIGH CONDUCTIVITY ROUND COPPER CONDUCTORS.

Cable. Strands and Size.	Total Cross-section Area in sq. inches.	Resistance in ohms per 1000 yds.	
		For Continuous Currents.	For Alternating Currents. Frequency 100 ~ per second.
7/18	·0126	1·974	1·974
7/17	·0172	1·452	1·452
7/16	·0225	1·108	1·108
7/15	·0285	·878	·878
7/14	·0351	·712	·712
19/18	·0351	·712	·711
19/17	·0477	·524	·524
19/16	·0624	·401	·401
19/15	·0789	·318	·318
19/14	·0973	·257	·257
19/13	·1289	·194	·195
19/12	·1645	·153	·155
19/11	·2048	·122	·1247
19/10	·2500	·100	·1034
37/16	·1227	·204	·2041
37/15	·1551	·162	·164
37/14	·1913	·131	·1334
37/13	·2534	·099	·1024
37/-	·3000	·083	·087
37/12	·3235	·077	·081
37/11	·4000	·063	·068
37/10	·4905	·051	·057
61/15	·2582	·097	·1004
61/14	·3185	·078	·082
61/13	·4218	·060	·065
61/-	·5000	·050	·056
61/12	·5385	·046	·052
61/-	·6000	·041	·048
61/11	·6476	·039	·0465
61/-	·7000	·0357	·0435
61/10	·8167	·0305	·0391
91/13	·6354	·0385	·0458
91/-	·7500	·0330	·0412
91/12	·8111	·0305	·0391
91/-	·9000	·0277	·0370
91/11	1·0000	·0250	·0350

pacity equal to K, then if R_o is the radius of the inside of the outside tube, and R_i is equal to the radius of the outside of the inner tube, and if L is the length of the tubes, the capacity of this concentric cable in microfarads is given by this expression:

$$C = \frac{K\,L}{2(\log R_o - \log R_i)}\;\frac{1}{2\cdot303 \times 9 \times 10^5}$$

Then, as regards the value of K for paper insulation, such as is used in the Ferranti cables, K has a value very nearly equal to 3; but if India rubber is used, then K has a value very nearly equal to 4. On calculating out these values for most ordinary cables used for the conveyance of high tension alternating currents, it will be found that for such insulating materials as paper, Fowler-Waring composition, or various resinous substances, the capacity of the cable is generally about one-third of a microfarad per mile.

From what has been said above with regard to the resistance effect, it must be noted that in the construction of a concentric cable the maximum thickness of the copper conductor cannot be more than about half inch. In cases where larger currents have to be conveyed than can be carried through the equivalent of a 19/12 cable, it is desirable to employ two concentric cables in parallel. Let us consider, then, the capacity effects. If a long concentric cable is connected to an alternator, the far end of the concentric cable being insulated, it is found that an electric current flows into and out of the cable, which may be sufficient to light one or more incandescent lamps. This is called the capacity current of the cable, and it is a current flowing across the dielectric or nonconductor from one copper member to the other. If C is the capacity of the cable measured in microfarads, V the difference of potential between the two copper members measured in volts, and if p represents 2π n, where n is the frequency, then the capacity current, I, is given by this expression:

$$I = \frac{C,\ p,\ V}{10^6}$$

Thus, for example, supposing a cable having a capacity current one-third of a mile capacity has a potential difference of 2,000 volts between its inner and outer conductors, and p equals 500, then the capacity current is one-third of an ampere, or equivalent to the lighting current of one 8 candle power lamp. Hence, in very large concentric systems, this capacity current going out of the station may amount to a considerable value. We have then to consider briefly what are called the resonance effects. If an alternator is separately excited so as to give a certain potential difference at its terminals, suppose 2,000 volts, and if a long length of concentric cable is connected to this alternator, the far end of the cable being insulated, then it will be found that such cable, when associated with the alternator, may greatly increase the electric pressure between the terminals of the alternator, and that for a certain critical length of the cable a very marked rise in pressure may take place. The same will be found to be the case if a long length of concentric cable is connected to the high pressure side of a step-up transformer being excited from a 100 volt alternating circuit on the low pressure side. Accordingly, in testing concentric cables, the engineer must always be on his guard against this resonance effect. Suppose, for instance, it is desired to test whether a certain length of concentric cable will stand 2,000 volts, the most natural method of doing this would be to connect the high pressure side of a step-up transformer, raising the volts from 100 to 2,000, and to serve the low pressure side of this transformer from a 100 volt circuit. The inexperienced person might naturally suppose that this would invariably place upon the cable a pressure of 2,000 volts, but under certain conditions, depending upon the capacity of the cable and the inductance of the transformer, the pressure might rise far beyond 2,000 volts between the two members of the cable, and the only method of making sure that this is not the case is to have an electrostatic voltmeter kept connected between the inner and outer members of the cable as the pressure is gradually increased.* Then, in the last place, not only are there the resonance effects above referred to, by which a concentric cable when switched on to an alternator or transformer permanently raises the pressure, unless the exciting current of the alternator is reduced, but there are certain very important initial effects which take place at the moment when a concentric cable is switched into connection with either an alternator or another live cable. If a condenser is connected with an inductive resistance, it can be shown that at the moment when this system is brought into connection with the source of alternating electromotive force, if the connection is made at a particular instant with respect to the phase of the electromotive force, there is an electrical oscillation set up in the combined condenser and inductive resistance, the amplitude of the oscillations of current greatly exceeding those which would exist when the steady state has been established, and oscillations of potential difference occur at the same time, the result of which is that the difference of potential between the two plates of the condenser will undergo a periodic change, the amplitude of the oscillations of which is, however, in the initial stage much greater than that of those which take place when the whole system has settled down into a steady condition under the influence of the impressed periodic electromotive force. Suppose, then, that a series of transformers are connected to the two copper members of a concentric cable, and that the concentric cable is, as usual, lead covered and steel armored with a layer of insulation between the lead covering and the outer copper members. As already stated, there is a certain capacity in the concentric cable between the inner and the outer members, which will be usually about one third of a microfarad a mile, but, at the same time, there will be a capacity between the outer member of the concentric cable and the lead casing or the earth; and this capacity between outer and the earth, as it is called, is very much larger in general than the capacity between the inner and outer; it may be ten times as great. Hence, if the transformers are connected between the inner and outer conductors we may regard the primary circuits of the transformers, which are inductive circuits, as connected in series with a condenser, which is formed of the outer members of the cable and the lead covering. If, therefore, such a cable, with transformers attached to it, the secondary circuits of which are unloaded, is switched into connection with the omnibus bars of an alternating current station, the connection between the inner member of the cable with the proper omnibus bar being made first, then, at that instant, an electromotive force is impressed upon the system, consisting of the inductive primary circuits and the condenser in series with them. For a particular phase of the impressed electromotive force, it can be shown that oscillations of potential are set up in the condenser, causing a periodic potential difference between its two sides to be greater than that due to the steady action of the periodic electromotive force. This sometimes results in breaking down the insulation between the outer members of the concentric cable and the lead covering, and as this insulation is generally in all cases made much thinner than that between the inner and outer members of the cable, it is not unfrequently pierced. Alternating current station engineers are very familiar with failures of such concentric cables occurring between the outer members of the cable and the earth. The remedy for this is one of two things, first the outer member of the concentric cable must be connected to its proper omnibus bar before the inner member of that concentric cable is connected. If this is done, then it is impossible to set up destructive oscillations of pressure between the outer members of the cable and the lead covering.

Another remedy is to introduce in the circuit with the inner member of the concentric cable a variable inductance which is gradually removed in such fashion that the inner member of the concentric cable is not connected suddenly with the source of potential, but is connected through a choking coil, the choking quality of which is gradually removed. This can be done in the following manner:

A large transformer is arranged so that its secondary circuit can be gradually short-circuited by lowering two lead or iron plates into an insulated tub of water; the primary circuit of this transformer can be connected in series with the inner member of the concentric cable which is to be brought into connection with the system. The operation then of connecting the long concentric cable to the omnibus bars is as follows:

The series transformer first has its secondary circuit opened, its primary coil is then connected in series with the inner members of the concentric cable to be connected, and with the proper omnibus bar, the outer member of the concentric cable is then connected with the other omnibus bar, the plates on the secondary circuit of the series transformer are then gradually lowered into the water, and when the secondary circuit of this series transformer is practically short circuited the primary circuit of the transformer is also short circuited, and the transformer is then removed, leaving the main in connection with the omnibus bars. The operation, moreover, is performed in such a manner that there is no rush of current into the cable, and no possibility of setting up violent oscillations of potential between the outer members of the concentric cable and the earth. In no case should long concentric bars be connected to omnibus bars or to other parts of an alternating current system without some such process as the above, of gradually setting up the full current in them, or else the risk of piercing the outer insulation of the concentric cable is very considerable. Engineers, in connection with alternating current stations, should always be on their guard against these initial effects, and remember that long concentric cables, with transformers connected to them, possess a quality which resembles inertia, and that currents can no more be started and stopped instantly in these cables and transformers than heavy machinery can be started and stopped at once.

In addition to the initial effects taking place in cables, I showed, in 1892, that there were certain initial effects, called current rushes, taking place in transformers when suddenly switched into connection with a live cable.

Under some circumstances, depending upon the phase of the electromotive force in which the switch is closed, a strong rush of current may take place into the primary circuit of a transformer, the maximum value of that current rising to twice the maximum value of the current when the steady state is established; and, under some conditions, in switching off a transformer, there may be a certain rise in the difference of potential between the parts of the primary circuit and the iron case or secondary circuit which may pierce the insulation. If a large current is flowing in an inductive circuit, and a switch is suddenly opened, interrupting that circuit at an instant when the current has its maximum value, then a large inductive electromotive force is set up in that circuit which may result in breaking down the insulation between parts of that circuit. The effect arises from the same cause that frequently destroys the insulation of a field magnet of a continuous current motor or dynamo, if the field magnet is suddenly switched off at a moment when the magnet is in a state of excitation.* Broadly speaking, as a practical rule, it should be remembered that long concentric cables having transformers lightly loaded connected to their ends should never be suddenly switched into connection with alternators, or switched off, but should always be put into connection with the source of electromotive force through a regulating resistance or inductance, so arranged as to prevent or check the formation of any oscillations of current other than those due to the natural period of the impressed electromotive force. In the early days of the working of many large alternate current stations many difficulties were experienced, owing to the failure of large transformers and the piercing of long concentric cables which were due to these causes, but all experience has now shown how to overcome these difficulties, and to prevent any of these disastrous initial effects. In many cases cables and transformers which suddenly fell when switched into connection with the circuit after being idle for a time have really been injured at the instant when they were last switched out of connection with the working system, owing to the rise of potential that has taken place at the instant when the current was interrupted at a particular instant during its phase. Hence the removal of a cable from a working system at the omnibus bar or at any intermediate point must always be effected with the same care as the connection of a cable, and in no case should a long concentric cable, whether connected to transformers or not, be switched on or switched off from the live omnibus bars of the station abruptly. This, of course, does not apply so much to short lengths of a few hundred yards as to long lengths of one or more miles, but it behooves the engineer always to be on his guard against these sources of failure.

The time will not allow me now to develop at any greater length these points, and in closing this brief discussion on the construction and action of transformers, there is no need to emphasize the fact that much

* For a further discussion of these resonance effects, the reader is referred to "The Alternate Current Transformer" (Fleming), vol. ii, p. 383 et seq., where a full discussion of these effects in connection with concentric cables is given.

* For further information on these initial effects, see "The Alternate Current Transformer," Fleming, new edition, vol. i, p. 201. Also "The Electrician," vol. xxx, p. 543. L. Neustadt, "On Concentric Cable Phenomena."

has perforce been omitted owing to the limits of our time, which a complete treatment would necessarily include. I have endeavored to direct attention rather to a few principal practical considerations, and to portions of the subject not quite elementary in character, and to assume, as I said at the beginning, that the fundamental principles were already familiar to most present.

Great as has been the progress in ten years in alternate current working, no one would be so rash as to assume that we have reached the limit of its improvement. The practical perfection of the transformer placed in the hands of electrical engineers an instrument of enormous utility and power for effecting the distribution of electric current. Large as may be our indebtedness to those whose scientific and constructive ingenuity has brought about this advance, we must at the same time remember, with due meed of honor and praise, the pioneering experiments of Paul Jablochkoff and Lucien Gaulard, in 1887 and 1882, which, even if not the first suggestions for the employment of the induction coil in electric lighting, certainly forced the attention of engineers to consider closely the value and use of that device, and the service it might be brought to render in the solution of the problems of public and private electric supply.

THE MORE IMPORTANT INSECTS INJURIOUS TO STORED GRAIN.*

After the grain has escaped the ravages of its many insect enemies in the field, and is harvested and in the bin, it is subject to the attack of insects of several species popularly known as weevils.

Of the species known to attack stored cereals in the United States nearly all have been introduced and are now cosmopolitan, having been distributed by commerce to all quarters of the globe. In fact, no insects are more easily carried from one land to another, since they breed continuously for years in the same grain, and are transported when in an immature state in the kernels.

In their native homes in the tropics, and even in our Southern States, these insects live an outdoor life, but in the colder countries of the temperate zone and in our Northern States they lead an artificial or domestic existence, the beetles, particularly, with few exceptions, passing their entire lives wholly within doors, being, therefore, dependent upon man for their subsistence.

When it is considered that grain constitutes the chief article of diet of man, and that these insects have found their way to every tropical and temperate region where grain grows, it may be said without fear of contradiction that they are entitled to front rank among noxious insects.

NATURE AND EXTENT OF DAMAGE.

In addition to the loss in weight occasioned by these insects, grain infested by them is unfit for human consumption, and has been known to cause serious illness. Nor is such grain desirable for food for stock. Horses, it has been experimentally proved, are injured by being fed with "weevily" grain, and it is somewhat doubtful if such material is fit even for swine. Poultry, however, feed upon it with impunity. "Weeviled" grain is also unfit for seed stock, as its use is apt to be followed by a diminution in the yield of a crop.

As regards the insect injury to stored grain in this country, one writer has estimated that there is "an annual loss of over $1,000,000 from weevils in Texas alone," and that nearly 50 per cent. of the corn in that State is annually destroyed by weevils and rats. Another writer has expressed the opinion that the annual loss to Texas from the injury to grain in the field and in the bins will amount to hundreds of thousands of dollars. The loss from granary insects to the corn crop in Alabama in 1893 was estimated at $1,671,382, or about 10 per cent.

THE GRANARY WEEVIL.

(Calandra granaria Linn.)

The granary weevil is the "curculio" and "weevil" of early writings, and in the Georgics of Virgil there is evidence that the insect and its ravages were known before the Christian era. It is probable that this, as well as some other cosmopolitan species that are generally supposed to have originally inhabited the Orient, is native to the Mediterranean region. Having become

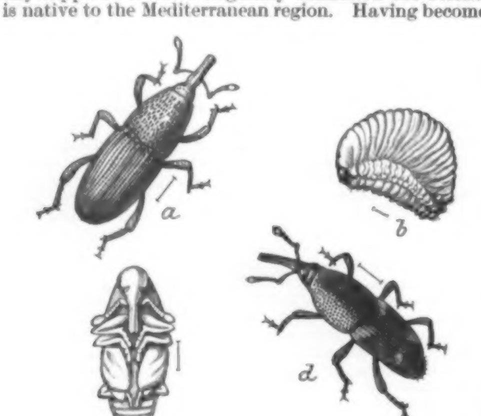


Fig. 1.—Calandra granaria: a, adult beetle: b, larva; c, pupa: d, Calandra oryza, beetle—all enlarged (from Chittenden).

domesticated ages ago, it has long since lost the use of its wings, which are present only as mere rudiments and useless as organs of flight. It is strictly a granary insect, and is apparently perfectly naturalized in regions much farther north than are inhabited by the rice weevil.

The adult granary weevil is a small, flattened snout-beetle of the family Calandridæ, measuring from an eighth to a sixth of an inch, being on an average a trifle larger than the rice weevil, from which it differs in being of a uniform shining chestnut-brown color, in having the thorax sparsely and longitudinally punctured, as indicated at Fig. 1, a, and in being wingless. The head is prolonged in front into a long snout or proboscis, at the end of which are the mandibles; the antennæ are elbowed and are attached to the proboscis.

The larva is legless, considerably shorter than the adult, white in color, very robust, fleshy, and of the form shown in the illustration (b). The pupa, shown at c, is also white, clear, and transparent, exhibiting the general characters of the future beetle.

The female punctures the grain with her snout and inserts an egg, and from this is hatched a larva which devours the farinaceous interior and undergoes its transformations within the hull. In wheat, barley, and other small grains a single larva inhabits a kernel, but a kernel of maize furnishes food for several individuals.

THE RICE WEEVIL.

(Calandra oryza Linn.)*

The rice weevil derives both its popular and Latin name from rice (Oryza), in which it was first found by its discoverer. It is conceded to have originated in India, whence it has been diffused by commerce until it is now established in most of the grain-growing countries of the world. There is no record of the occurrence of this insect in Europe earlier than 1763, when the species was described by Linnæus, but it was probably imported into southern Europe many years prior to that time. From Europe it was introduced into America, and at the present time is as widely distributed and injurious as any known insect. It is a serious pest in the Southern States, where it is commonly, though erroneously, known as "black weevil," but farther north it is of less importance. It occurs, however, in every State and Territory in the Union and occasionally invades Canada and Alaska.

The rice weevil resembles the preceding species in size and in general appearance. It is dull brown in color; the thorax is densely pitted with round punctures; the elytra, or wing cases, are ornamented with four more or less distinct red spots, arranged as in the illustration (Fig. 2, d), and it has well developed and serviceable wings. The larvæ and pupæ are also similar to those of the granary weevil, and in habits and life history it does not differ materially from that species.

THE ANGOUMOIS GRAIN MOTH.

(Gelechia cerealella Ol.)

The Angoumois grain moth derives its name from the province of Angoumois, France, where it is said to have been injurious for nearly a century and a half. It probably originated, with the granary weevil, in the Mediterranean region, and possibly in southern Europe. In this country it is familiarly but incorrectly called the "fly weevil."

The history of the insect in Europe dates back to 1736, when Réaumur found it damaging stored barley in France, but the moth was not described until 1789. In America an account by Col. Landon Carter, published in 1771, brought out the fact that injuries from this species began in North Carolina as early as 1728.

From the seat of its original introduction this moth has spread to neighboring States in the South, where it does incalculable damage, and to the southern portions of the Northern States, where it is less injurious. It is occasionally troublesome as far north as Canada, and has been reported as doing serious damage in Australia and India. The work of the writer at the Columbian Exposition would indicate that it has now become cosmopolitan, as it was found there in a majority of the cereal exhibits of the tropical and warmer temperate countries.

In Europe the favorite food of the Angoumois moth is said to have been barley; in America its chief injury is to corn and wheat, but it infests also all the other cereals, as well as buckwheat, chick-peas, and, it is said, cow-peas. It has been estimated that in six months grain infested by this moth loses 40 per cent. in weight and 75 per cent. of farinaceous matter. In addition to the loss in weight, the grain is totally unfit for food, and it has been said that bread made from

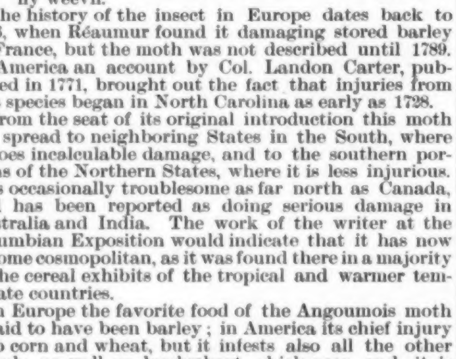


Fig. 2.—Gelechia cerealella: a, larva; b, pupa; c, ♀ moth; e, egg; f, kernel of corn opened, showing larva feeding; h, anal segment of pupa—all enlarged except f (from Riley in Ann. Rept. Dept. Agr., 1884).

wheat injured by this moth was the cause of an epidemic in certain regions of France infested by the species.

This insect is a small moth of the family Gelechiidæ and resembles somewhat our familiar clothes moths, for which species, indeed, it is often mistaken. It is light grayish brown in color, more or less lined and spotted with black, and measures across the expanded fore wings about half an inch (see Fig. 2, c). The hind wings are bordered with a long, delicate fringe.

The moth normally deposits its eggs in standing grain, singly or in clusters of from twenty to thirty. The eggs, shown at Fig. 2, e, are red in color and hatch in from four to seven days, when the minute caterpillars burrow into the kernels and feed on the interior. A single larva inhabits a grain of the smaller cereals, but in maize sustenance is afforded for two, three, or more individuals. Fig. 3 represents an ear of popcorn infested by this moth. In about three weeks' time the caterpillar attains full growth (see Fig. 2, a), when, without leaving the kernel, it spins a thin, silken cocoon in which it transforms to a chrysalis (Fig. 2, b), the moth emerging a few days later, the entire period from egg to adult embracing in summer from four to five weeks. In this latitude there are probably five or six generations annually. Mr. H. E. Weed estimates that in the warmer climate of Mississippi, where the insect can breed uninterruptedly during the winter months, there are at least eight generations.

In some respects the Angoumois grain moth is more troublesome than any of the other granary insects. Even as far north as central Pennsylvania it lays its

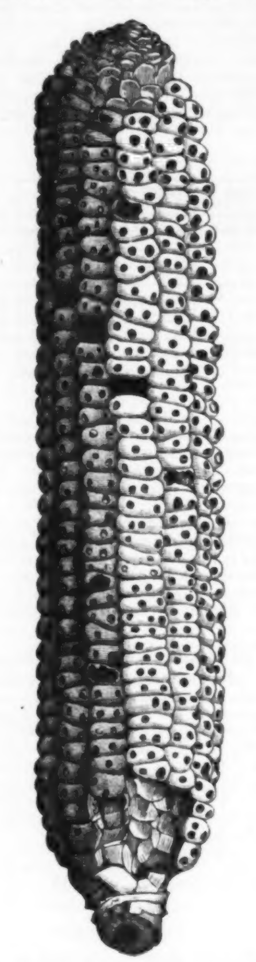


Fig. 3.—Ear of popcorn showing work of Angoumois grain moth (from Riley in Ann. Rept. Dept. Agr., 1884).

eggs on grain in the field, and it is, therefore, impossible to entirely prevent infestation. The custom of leaving the harvested grain in stack in the field for weeks before threshing, in vogue in some parts of our country, is the cause of perhaps the greatest proportion of infestation.

The introduction of the insect into the granary through this channel may be practically prevented in the case of the smaller cereals by harvesting and threshing as soon as possible after the grain reaches maturity. If, after the removal of the old grain from bins, these are thoroughly cleaned and fumigated before the introduction of fresh grain, the chances of injury are reduced to a minimum.

This, as well as the other granary moths, is soft, delicate and easily crushed, and is unable, when buried beneath a large mass of grain, to extricate itself; hence storing the grain in bulk and stirring, shoveling or agitating by other means is productive of the best results with this insect.

THE MEDITERRANEAN FLOUR MOTH.

(Ephestia kuehniella Zell.)

This scourge of the flour mill, as it is called, has attracted much attention of recent years and has been the subject of many articles and bulletins. Until the year 1877, when the moth was discovered in a flour mill in Germany, it was comparatively unknown. In later years it invaded Belgium and Holland, and in 1887 appeared in England. Two years later it made its appearance in destructive numbers in Canada.

That the Mediterranean flour moth has become so formidable in recent years is due to the higher and more equable temperature maintained in modern mills, a condition highly favorable to the development of the insect.

Previous to the Canadian invasion this moth was generally believed to have reached Europe from America, but, as a matter of fact, the species had not been recognized here until 1889. Danysz has traced its occurrence in this country back as far as 1880. He mentions also an outbreak in Constantinople in 1872 and presents evidence that it was probably known in Europe as early as 1840. Until the present year this insect was known as injurious on this continent only in Canada and California, but in the American Miller of May 1, 1895, Mr. W. G. Johnson states that it has appeared in New York State. It is recorded also from North Carolina, Alabama, New Mexico, Colorado, Mexico and Chile, and probably occurs in Australia.

The adult moth has a wing extension of a little less than an inch; the fore wings are pale leaden gray, with transverse black markings of the pattern shown in the accompanying illustration (Fig. 4, a); the hind wings are dirty whitish, semitransparent and with a darker border. The caterpillar is illustrated at c, e and the chrysalis at d.

The caterpillars form cylindrical silken tubes in which they feed and transform to chrysalids, and it is this

* By F. H. Chittenden, Assistant Entomologist, United States Department of Agriculture. Reprinted from the Yearbook of the United States Department of Agriculture for 1894.

* The specific name of the rice weevil has uniformly been spelled "oryzæ" by all writers since the time of Linnæus, but the original spelling is oryza. (See Amœn. Acad., Vol. VI, p. 395.)

habit of web spinning that renders the insect so injurious where it once obtains a foothold. The flour becomes felted together and lumpy and the machinery becomes clogged and necessitates frequent and prolonged stoppage, resulting in a short time in the loss of thousands of dollars in large establishments. Upon attaining full growth, the caterpillar usually leaves its original silken domicile and forms a new web, which becomes a cocoon, in which to undergo its transformations to pupa and to imago.

Although the larva prefers flour or meal, it will attack grain when the former are not available, and it flourishes also on bran, prepared cereal foods, including

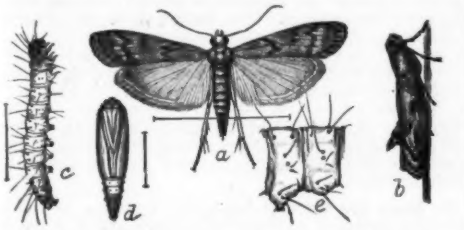


FIG. 4.—Ephestia kuehniella: a, moth; b, moth, from side, resting; c, larva; d, pupa—enlarged; e, abdominal joint of larva—more enlarged (b, c, e, from Insect Life; a and d, from Chittenden).

buckwheat grits and crackers. It has recently been discovered that this moth is inquilinous in the nests of a wild bumblebee in California, and Mr. D. W. Coquillett reports that it also occurs in the hives of the entire honey bee.

M. Danysz has demonstrated that the insect is able to complete its life cycle in from two to two and a half months, but from experiments conducted during the year at Washington it is estimated that under the most favorable conditions, i. e., in the warmest weather, the life cycle consumes about five weeks. In its outdoor life there are probably not more than two or three broods in the year, but in well heated mills or other buildings six or more generations may be produced.

This insect is rapidly becoming distributed throughout the civilized world, but as yet its range is limited. As might be inferred from its alarming destructiveness in Great Britain and Canada, this moth is peculiarly qualified for an indoor existence in much colder climates than most other grain insects.

When a mill is found to be infested, the entire building should be fumigated, and in case a whole district becomes overrun, the greatest care must be observed not to spread the infestation. Uninfested mills should be tightly closed at night and every bushel of grain, every bag or sack, brought into the mill, subjected to a quarantine process, being disinfected either by heat or bisulphide of carbon.

THE INDIAN-MEAL MOTH.

(Plodia interpunctella Huebn.)

A phycitid moth allied to the preceding and known as the Indian-meal moth is widely distributed and injurious to a great variety of edibles. It is nearly omnivorous, feeding on grain and farinaceous products of all kinds, dried fruits, seeds and nuts of various sorts, condiments, roots and herbs. It is even injurious to dried insects in cabinets, and is said to feed on sugar, jellies and yeast cakes, and is occasionally troublesome in bee hives. In short, this moth is an all around nuisance in granaries and stores and in the household. It is the caterpillars of this species which are so often found in dried apples, currants, raisins, English walnuts, etc.

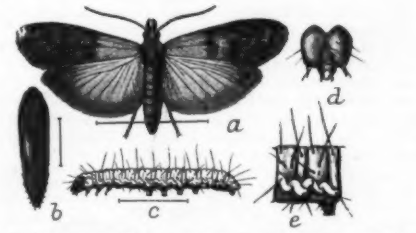


FIG. 5.—Plodia interpunctella: a, moth; b, chrysalis; c, caterpillar—somewhat enlarged; d, head, and e, first abdominal segment of caterpillar—more enlarged (from Chittenden).

The adult moth, as will be seen by reference to the accompanying illustration (Fig. 5, a), resembles in general contour Ephestia kuehniella. It measures across the expanded wings between a half and three-fourths of an inch. The inner third of the fore wings is dirty whitish gray, and the outer two-thirds is reddish brown, with a dull coppery luster. The caterpillar is shown at c, e and d, and the chrysalis at b.

Aside from its omnivorousness, the habits of the Indian-meal moth are essentially the same as those of the preceding species. The larvæ surround themselves with cylindrical silken webs, in which they feed and undergo their transformations.

Experiments conducted during the past year show that the insect is capable of passing through all its several stages, from egg to adult, in thirty-three days, which furnishes a possibility of six, seven, or even more generations in the heated atmosphere in which it habitually lives.

THE MEAL SNOUT-MOTH.

(Pyralis farinalis Linn.)

A moth belonging to the family Pyralidæ often occurs in barns and other buildings wherever farinaceous products are housed. In Europe, where it is known as the "meal moth," it has long been known as a domestic nuisance, and in this country it is evidently on the increase.

The meal snout-moth is slightly larger than any of the species previously mentioned, having a wing expanse of nearly an inch. The ground color is light brown, with reddish reflections; the thorax and the dark patches at its sides and near the tips of the fore wings are darker brown. The wavy, transverse lines of the wings are whitish, and form the pattern indicated in the illustration (Fig. 6, a). The caterpillar

FIG. 6.—Pyralis farinalis: a, adult moth; b, larva; c, chrysalis—natural size; d, head of larva; e, anal segment of same; f, tip of pupa—enlarged (from Chittenden).

and chrysalis are figured, natural size, at b and c, respectively. The habits of the meal snout-moth are similar to those of the two preceding species.

THE WOLF MOTH.

(Tinea granella Linn.)

Still another moth, known as the wolf moth or little grain moth, does considerable injury to stored cereals in Europe; but as it is not particularly destructive in America, requires only passing mention. This species is of about the size of the Angoumois moth, creamy white in color, thickly mottled with brown. Like the latter, it is known to oviposit in grain in the field. It infests cereals of all sorts, and a single caterpillar is capable of great damage, as it has a habit of passing from one grain to another, spinning them together with its webs as it goes until twenty or thirty grains are spoiled. When full grown the caterpillars crawl all about the infested mass, leaving their webs everywhere, thus injuring even more than they consume.

(To be continued.)

THE HABITABILITY OF OTHER WORLDS.

Prepared by Prof. C. A. YOUNG, of Princeton, for the New York Herald.

FOR some reason not quite obvious to the professional astronomer, there seems to be an extreme popular interest in the question of the habitability of "other worlds," and of late it has been greatly intensified by the rather sensational speculations and deliverances of Flammarion, Lowell and others—speculations based upon new discoveries reported within the last ten or fifteen years, some of which are doubtless real, while others are still more or less questionable.

I may as well say at the outset that, in my judgment, we have not yet any satisfactory basis for a confident opinion. The available data are insufficient, and, what is worse, they in some cases seem to indicate opposite conclusions.

As to the general question whether the stars and planets are the abodes of life, we can, of course, say positively, on the one hand, that they may be. Plainly the omnipotent Deity can, if he sees fit, organize forms of life suited to any possible conditions, creatures that might flourish in the solar fire or in nebular fog. On the other hand, there is not the slightest valid evidence that such creatures exist. Considering the "vast emptiness" between the stars, and the lifeless ages of the earth's early history, as revealed by geology, one cannot argue that material globes must be inhabited. Unoccupied space, lifeless millenniums and worlds uninhabited all fall into the same category of unexplained use.

But, if we narrow the question, and inquire as to the possibility of forms of life such as we are acquainted with upon the earth, the case is different. We are able to say at once, and with absolute confidence, that there are only two among all the heavenly bodies observable with our present telescopes upon which anything like terrestrial life could possibly exist. The two are Venus and Mars; upon all the rest the conditions are clearly too different from our own.

But the limitation must not be lost sight of—there may be, and very likely there are, circulating around some of the distant suns planets not very unlike the earth and well enough suited for even human life. But, if such planets exist, we cannot see them with any telescope yet constructed or ever likely to be. To make them visible would require lenses from 50 to 100 feet in diameter.

Speculation may be allowable in the premises, but dogmatism certainly is not.

As to the planet Venus, we need say very little here. In diameter, mass, density and the force of gravity upon her surface, she is the earth's twin sister. She is so much nearer than we are to the sun that she receives from him almost twice as much heat and light as we do, but as to the character of her surface, we know almost nothing. Unquestionable observations prove that she has a denser atmosphere than ours, and it is probably always filled with cloud.

At any rate, no distinct and well marked features have ever been detected on her surface, and there is no reason to suppose that the cloud veil has ever lifted.

With Mars the case is different; we know more about him than we do about any other heavenly body, the moon excepted.

We may reckon up our stock of certain knowledge about this planet somewhat as follows:

In the first place, its orbit is about once and a half as large as the earth's, and it makes its circuit in 687 days, at a distance from the sun which ranges between 128,000,000 and 150,000,000 miles, the mean being 141,500,000. Once in every 730 days the earth overtakes it, passing between it and the sun, and if this happens in the latter part of August, the distance between us will be the least possible—only about 35,000,000 miles.

No other heavenly body, except the moon and Venus, and now and then a comet, ever come so near.

Still, this is not so very near, after all. Thirty-five million miles is 147 times the distance of the moon, so that, even with a magnifying power of a thousand (and only the largest telescopes, under the most favorable conditions, can ever use so high a power to advantage), we see the planet's surface just as we view the moon through a common field glass magnifying seven times. And most of our observations are made, of course, at a distance much greater than this minimum.

Moreover, since the planet's distance from the sun averages something more than once and a half that of the earth, it is certain that Mars receives less than half as much solar heat and light as we do—an unquestionable and most important fact.

In the next place, we know that the diameter of Mars is about 4,200 miles (somewhat more than half that of the earth), and that it rotates in 24 hours 37 minutes 22·65 seconds around an axis so situated that the planet's equator is inclined about 24° to the plane of its orbit. This is so nearly the same as the inclination of the earth's equator that we safely infer that Mars must have seasons very like those of the earth; though notably modified by the considerable variations in its distance from the sun at different parts of its orbit.

In the third place, from the motions of its two little moons, we can calculate with certainty the weight or "mass" of the planet, and we find it to be less than one-ninth ($\frac{1}{9}$) that of the earth. From this it follows also that the planet's average density is 72 per cent. that of the earth, and the force of gravity upon its surface is not quite 38 per cent. as great as here.

A man who here weighs 160 pounds would there weigh only 60 pounds. If he were able here to jump to a height of five feet, there he would jump 13. So far as this condition goes, a Martian elephant might be as agile as a terrestrial deer.

Thus far there is no guesswork. We have stated knowledge, not speculation.

Once more. There are clear indications of an atmosphere upon the planet, though they are not such as to enable us to calculate with certainty its extent and density. The atmosphere ought to be much less extensive and dense than ours, on account of the lessened force of gravity, and if the so-called "dynamical theory" of gases, now almost universally accepted among physicists, is true, it must be a little body, like the moon, or Mars cannot permanently retain an atmosphere like our own.

The inference is borne out, too, by the fact that clouds are only rarely observed upon the planet. As a rule, we see the features of its surface unveiled and clear. There is probably never a time when a distant observer would be able to see half the seas and continents of the earth unclouded and exposed to view.

Whether the Martian atmosphere contains any sensible quantity of water vapor is still a debated point. Some of the earlier observers reported that they could distinctly make out the characteristic lines of this substance in the planet's spectrum, but some of the best recent observers, notably Prof. Campbell of the Lick Observatory, have reached an opposite conclusion.

And now we come to a question of great difficulty—that of the planet's temperature.

Since the planet's atmosphere is certainly not dense, it is natural to conclude that the temperature at its surface, even if the sun's heat there were as intense as here, must be practically the same as that of places on the earth where the density of the air is correspondingly low, namely, at the tops of the loftiest mountains in the regions of perpetual snow.

And, recalling that on Mars the solar radiation is less than half as intense as here, the inference is almost irresistible that the temperature must be appallingly low, so low that, as on the moon, water, if it exists at all, can exist only as ice.

And yet while many astronomers—I myself for one—are disposed to think this probably true, it is only an inference, and not a certain one. Nor can it be denied, as we shall see, that phenomena observed upon the planet look very much like the deposit and melting of polar snows, the flow of water and the growth of vegetation.

It may be, perhaps, as Flammarion has suggested, that the planet's atmosphere, though rare, has some peculiar constitution that makes it more effective as a "blanket" than our own in its power to retain the solar heat; or it may possibly have some unknown source of heat; or again it may be that Fay's modification of the nebular hypothesis is correct, and that Mars, instead of being an older planet than the earth, as commonly supposed, may be a younger one, still retaining considerable of its original heat of condensation, and not yet cooled down to a permanent temperature corresponding to its distance from the sun.

But unless some cause operates to give it an abnormal temperature, the discussion need go no further. Life resembling that upon the earth could not exist there. The time may come, perhaps, before very long, when we may have heat measuring instruments of sufficient delicacy to give us certain information whether the planet's temperature is below zero or is similar to that of our habitable earth. Till then judgment hangs suspended.

As a telescopic object Mars is fine. Its ruddy disk is diversified with patches of greenish hue, which, in a small telescope, seem to form a sort of irregular bell around its equator, with several projecting angles which thrust themselves down into the northern hemisphere. The telescope invests the planet much as South America and Africa and India reach toward the south upon a terrestrial globe.

These dark regions cover about a third of the ball, and, until recently, have generally been interpreted as seas and oceans, and are named accordingly. But later observations make this very doubtful by showing such changes in their form and appearance, and such markings upon them, as to suggest rather that they are areas covered with vegetation.

Then, near one or the other of the poles, there is usually a "polar cap" of dazzling whiteness, and these caps grow and wane with the planet's seasons (as the elder Herschel discovered more than a century ago), just as they would do if they were composed of ice and snow. Sometimes, also, though rarely, as has been already said, there are whitish veils of cloud that obscure for a time the well-known features, and shortly vanish. All the time the planet whirls, and as the night wears on continents and seas pass slowly in review, coming up from the eastern edge of the disk and descending upon the western.

If the telescope is powerful enough, Hall's two little moons will be seen—Phobos, hurrying from one side to the other, close to the planet, and so rapidly that it takes him only three hours and three-quarters to make the whole excursion, while the smaller and more distant Deimos is more than four times as deliberate in his motion.

But the most interesting objects, if one can see them, for they require a keen eye, a first rate instrument, and

perfect atmospheric conditions, are the fine, dark, threadlike lines which cross the ruddy portions of the disk in various directions, in a most curious and suggestive manner. A few of them were noted as rather ill-defined shadings, long ago, but it was Schiaparelli, the Milanese astronomer, who, in 1887, first discovered them in any number, and named them "the canals," as resembling watercourses of some sort, running from sea to sea.

As to their real nature, there is still much doubt. Those who ignore the temperature difficulty, and believe that the polar caps are really sheets of snow which melt in the summer, for the most part accept the suggestion which the name implies, and regard them as marking the track of channels, natural or artificial, through which the water that results from the melting of the ice caps is distributed over the arid plains near the planet's equator. They suppose, at least this is the view of Flammarion and Lowell, that what we see is not the watercourse itself, but the fringe of vegetation which springs up along its banks when the water comes, like the harvest of the valley of the Nile.

And this certainly accords very well with the fact that these canals are not equally visible at all times, but are sometimes fairly conspicuous, while they vanish at others.

Possibly, too, one might deduce from this theory a satisfactory explanation of a very strange phenomenon exhibited by many of them, their "gemination," as it is called. They double themselves at times. A canal which had been a single, thin, dark line is replaced in a day or two by two that are exactly parallel and separated by a distance of from 100 to 250 miles. Some of these canals are over 2,000 miles in length, and appear to be as accurately straight as lines can be upon a sphere. They seem to follow a true great circle course.

At their points of intersection—and in several instances as many as half a dozen seem to converge as accurately to a single point as railroads to a city—small dark spots appear, which have received the name of "lakes." Mr. Lowell, however, prefers to call them "oases," believing them to be patches of vegetation which are formed where the converging channels bring an especially abundant supply of moisture.

And the fact that, according to Schiaparelli and the Flagstaff observers, some of the canals appear to invade, and pass across, the so-called "seas," of course proves, unless there is some error or illusion in the observations, that these darkly shaded regions are not bodies of water, but marshes, fields or forests.

We should have noted, as removing an objection to this watercourse theory of the "canals," that, so far as can be judged from observations, the planet's surface is much more level than that of the earth. There is no evidence of lofty mountain ranges, though a few projecting bright spots have been noted at the boundary of day and night on the planet's surface, which may indicate elevations having the height of two or three thousand feet.

And it is to be admitted also, I think, that no other explanation of the "canals" as yet proposed satisfies the reported appearances so well as that of watercourses. The only one not absolutely contradicted by direct observations is that they are fissures and wrinkles in the planet's crust, produced by its shrinkage over a comparatively unyielding nucleus. But, then, what is to be made of their "gemination"?

We have thus set forth the conditions of the planet so far as they appear to bear upon its possible habitability by living beings resembling in essential characteristics those that inhabit the earth. If we put aside, as Flammarion and Lowell have done, rather airily, we think, the serious difficulty as to temperature, and assume with them that the planet's water supply is extremely scanty—which can hardly be doubted, if water exists there at all—and that the planet's surface, for the most part an arid waste, is to some extent made fertile by the channels which distribute the water derived from the melting polar snow caps, it is clear that we have a condition of affairs which might make habitability of the sort contemplated a not absurd hypothesis.

And yet the great difference between the earth and Mars as to thinness of the atmosphere, the absence of clouds and the lessened force of gravity and solar radiation must necessitate a wide difference between the inhabitants of the two worlds.

Next comes the question whether, granting the possibility of life upon the planet, we have any evidence of its existence.

As regards vegetable life, its existence is, of course, assumed in the very plausible explanation which Lowell and Flammarion give of the "canals" and the seasonal changes observed in the features of the planet's disk. And they go further. Mr. Lowell finds evidence of intelligent design and engineering skill in the—according to him—perfect straightness of the long watercourses and the precision with which numbers of them converge to or diverge from certain centers. And he enters into interesting speculations as to the ability of the people of Mars to perform feats of engineering quite beyond our human powers.

In the first place, owing to the feebleness of gravity there the "men" of Mars might attain a strength and stature nearly three times as great as ours without incumbrance from their own weight, and dealing as they would have to with rocks only a little more than a third as heavy as they would be here, their work would be greatly more effective.

Then, too, Lowell, basing his speculation upon the generally received form of the nebular hypothesis (which, contrary to Faye's theory, makes Mars an older world than ours), argues that the Martians already possess the engineering skill, machines and appliances which we shall have upon the earth some ages hence.

Human beings may then find themselves upon a world nearly dried up, and may have to undertake irrigation on a scale suggested by what we see upon our neighbor.

Both Lowell and Flammarion remind us, however, very properly, that we must beware of assuming that the "men" of Mars—its intelligent inhabitants—are vertebral bipeds like ourselves. If intelligent beings exist there, the probabilities are strong that they are very different from us in ways which we can hardly conjecture, since the difference between the earth and Mars in physical conditions must almost necessarily have determined different lines of development on the two planets. Flammarion suggests, in a caprice of speculation it would seem, that the Martians are winged creatures, but whether bats, birds or butterflies, he does not attempt to decide.

There has been some speculation as to the possibility of establishing communication with our hypothetical neighbors, and some enthusiastic amateurs have reported glittering spots upon the planet's disk, and have tried to interpret them as hailing signals from the distant world.

These "lights," however, were in all probability mere reflections from favorably situated surfaces of the same material that compose the polar caps; and there is not the slightest probability that with any instruments we now possess we could distinguish any signals they could make. And, if we could, who could read them?

Still, it is always wise to be reticent in denying the possibilities of the future, and no less so to be cautious in accepting as ascertained truth the startling conclusions and unverified discoveries of imaginative observers. It is so easy to see what one expects and wishes to find, especially on a disk so small and delicately marked as that of Mars.

A LION-FACED BOY.

A COMPANY of Liliputians was recently exhibited at Castan's "Panoptikum," in Berlin, the most interesting member of which was unquestionably Stephan Sedlmayer, alias Bibrowski, the lion-faced boy. The bright little fellow is one of those rare specimens of human abnormality that are often called hairy men because of a growth of hair extending all over the body, but especially abundant on the face.

Stephan Sedlmayer is, to quote Rudolf Virchow, "a remarkable example of a hairy human being," and as such he aroused great interest in the Berlin Anthropological Society, to which he was shown by the learned man just referred to. His whole face, with the exception of the eyelids and the red portions of the lips, is covered, the blond hair growing over all of the forehead down to the eyebrows, so that his head looks very like that of a dog or lion. This impression is heightened by the peculiarly shy expression of his eyes and his rather large mouth and irregular teeth. The trunk and extremities of his body are also well covered with hair, which is particularly thick along the vertebral column. Otherwise his body is normal and strongly built. His mental capacity compares very favorably with that of other boys of his age and class; he is intelligent and has a mild and confiding disposition. He is a master of the German language and also of Polish, his mother's language, for Stephan was born in the government of Warsaw.—Illustrirte Zeitung.

A LION-FACED BOY.

In comparing equal weights of wood and metal, the latter does not always prove the stronger. For example, a bar of pine just as heavy as a bar of steel, an inch square, will sustain 125,000 pounds, the best ash 175,000 pounds, and some hemlock 200,000 pounds, without breaking. The best steel castings made for the United States navy are rated at a tenacity of 65,000 to 70,000 pounds to the square inch. By solidifying such castings under a great pressure, a tensile strength of from 80,000 to 150,000 pounds has been attained. Fine steel wires and ribbons from ingots give a tenacity of 300,000 pounds to the square inch of cross section. Ordinary aluminum is only one-third as heavy as steel. A bar of it, with a section of three square inches, will hold up 78,000 pounds.

SELECTED FORMULÆ.

Hypo Baths in Warm Weather.—In warm weather the hypo bath is apt to be troublesome. It rapidly evaporates, changes color and stains the negatives, and often acts deleteriously on the gelatine film. I add to my bath chrome alum and acid sulphite of soda. The bath now not only remains quite clear and clean, but clears and hardens the negative, making washing easier, in that the tendency to frill is minimized. The bath may be kept for several weeks; indeed, it may be used until it changes from a bright green color to a brownish tint. Of course, in very warm weather, the bath should be kept cold by standing the tray containing it in a pan of ice water an hour or so before development is commenced. The bath I prefer is made up as follows:

Hypo	4	oz.
Chrome alum	¼	"
Acid sulphite of soda	½	"
Water	1	qt.

Dissolve the hypo, add the chrome alum, then filter and add the sulphite. Evaporation of the bath is prevented by keeping the dish covered when not in use.—Helping Hints.

To Mask the Odor of Ichthyol.—In order to render the application of ichthyol less unpleasant, it is recommended (**Therap.** Monats.) to combine the same as follows:

Oil citronella	25	parts.
Oil eucalyptus	25	"
Ichthyol	950	"

Oil of Pinus sylvestris may be used instead of those given, but a much larger quantity will be required.—Western Druggist.

Cough Sirup.—

Honey	3	lb.
New England rum	3	pt.
Extract of licorice	1	oz.
Tincture opium	1	"
Wine of ipecac	2	"
Wine of ipecac, Wine antimony, of each	1	oz.
Sirup of wild cherry	14	"
Acetate of morphia	12	grm.

Dose, one-half to one teaspoonful.

Thick Sauce.—Take of

Moist sugar	1	lb.
Raisins	½	"
Onions	4	oz.
Powdered ginger	3	"
Salt	4	"
Mustard	8	"
Garlic, crushed	2	"
Large ripe apples	20	
Soy	10	oz.
Tamarinds	1	lb.
Curry powder	1	oz.
Vinegar	7 pt. 8	oz.

Stone and bruise the raisins, pound the onions and garlic finely in a mortar, pare and core the apples, and boil them with the other solid ingredients in the vinegar until soft; then rub through a sieve; add the other ingredients and mix thoroughly; lastly, add enough vinegar to make a thick, pourable, pasty fluid that just flows from the bottle.—Brit. and Col. Druggist.

Cosmetic Powder.—Under this general head may be included all the various pulverulent substances employed as cosmetics. The following are typical formulas:

1. Sweet almonds (blanched)	18	oz.
Beans (ripe, dry)	18	"
Orris root	8	"
White Spanish soap	6	"
Spermaceti	1½	"
Dried carbonate of soda	1	"
Oil of bergamot, Oil of lavender, Oil of lemon, of each	6	dr.

Mix, beat or grind to fine powder and keep this from the air. Used with a little water, to clean, whiten and soften the skin, in lieu of soap.

2. Almond powder	1	lb.
Cuttlefish bone (powdered)	5	oz.
Curd soap (air-dried, powdered), White castile soap (air-dried), powdered, of each	2½	oz.
Orris root (in fine powder)	1½	"

Mix, and pass the whole through a fine sieve. Used to clean, soften and whiten the hands and to prevent chaps and chilblains. It may be varied by substituting honey, palm oil or Windsor soap for those ordered above.—Pharmaceutical Era.

Blackboards, an Improved Liquid Composition for.—This liquid for surfacing blackboards used in schools is composed of:

Ferriferous corundum	340	parts.
Linseed oil	120	"
Resin	43	"
Manganese oxide	28	"
Lead protoxide	28	"
Turpentine	400	"
Benzine	6	"
Lampblack	35	"

The oil, resin, oxide of manganese and lead oxide are heated together up to the point of oxidation and until the resin is dissolved; the turpentine and benzine are then poured in and the mass allowed to cool, after which the lampblack and ferriferous corundum are added. Patented in England.—Journal of the Society of Chemical Industry.

Ink for Writing on Glass.—Take 20 parts of brown shellac, and dissolve in the cold in 150 parts of methylated spirit; dissolve 35 parts of borax in 250 parts of distilled water; then slowly pour the shellac solution in the borax; the mixture may then be tinted to any color by adding a solution of a water soluble dye, for instance, violet, with one gramme of methyl violet. This ink is said to be indelible, and to allow the marking of bottles without having recourse to labels, which are so readily destroyed.—Pharmaceutical Journal.

ENGINEERING NOTES.

The total length of railway lines open for passenger traffic in the United Kingdom was at the end of 1895 11,252 miles of double and 8,774 miles of single line.

The old Stephenson locomotive, which for some years has been standing on the Newcastle end of the High Level Bridge, is now being overhauled at the Gateshead Works of the Northeastern Railway Company, and will shortly be placed on the pedestal erected for it under the roof of the Central Station, where it will be protected from the weather, as the old "Locomotion" is at Darlington Station.

The works for the construction of a canal connecting Lake Thrasimenus with the Lake of Perugia, to keep the waters of the former at a constant level, was recently inaugurated. The Ministers of Finance and the Treasury and the Under-Secretary of Public Works were present. The canal is entirely due to the initiative of the local proprietors, who formed a syndicate, and after twenty years of incessant effort have at last brought the project to a successful issue. The canal will prevent the waters of the lake flooding the surrounding country, which threatened to become marshy, owing to repeated inundations.

A German contemporary, says the Engineer, gives particulars of experiments carried out at Riga, with a view to testing the durability of brickwork constructed in frosty weather. It was found that brickwork erected during the cold season, using ordinary mortar prepared with warm water, proved very unsatisfactory in point of resisting power; nor was any improvement effected by dissolving in the water one-half per cent. of calcium chloride, but excellent results were obtained when the warm water contained one and three-quarters per cent. of common salt. The addition of freshly slaked lime to ordinary mortar gave satisfactory results, but better results were obtained by the exclusive use of freshly slaked lime, especially when used in conjunction with calcium chloride. It was found, too, that an admixture of Portland cement with common mortar increased its resisting power to frost. The best results were obtained with a mixture of Portland cement and five parts sand.

A remarkable exhibition of the power of modern explosives occurred recently at Marquette, Mich., in firing an iron range in one of the open pits. The amount of ore brought down from the east side of the pit is estimated at from 10,000 to 13,000 tons. Previous to the blast proper some 300 pounds of "giant powder" were exploded to loosen the ground, doing its work so effectively that some of the cracks in the ore were two inches in width, with, of course, many smaller ones. Immediately back of the larger crack, about forty feet from the end of the hanging, a large hole, thirty-five feet in depth, had been drilled, and in this hole over half a ton of black powder was placed; when the blast went off the ore ahead and forty feet on either side of the hole tumbed over into the huge pit. The latter is of mammoth size, indeed—some 150 feet in depth and more than 500 feet long by 400 feet wide; the entire east side is in solid ore, as is also a portion of the south side.—Boston Journal of Commerce.

Practical mechanicians will gather some helpful suggestions from a communication lately made to the French Academy of Sciences by M. Frement, on the changes that take place in a sheet of metal while it is having a round hole punched through it. Brass, copper, soft steel and wrought iron, in plates of twenty-five millimeters (one inch) thick, and steel punches thirty-five millimeters in diameter, were used. The die first employed was thirty-six millimeters in diameter, then one of thirty-nine was substituted, without altering the size of the punch; the hole made with the first die underneath was cylindrical, but with the other it was conical, and while the greatest resistance offered to the pressure was the same in both cases, the total resistance was much greater with the smaller die. It seems, too, that when the punch is one-third through the plate, the piece to be removed has been completely sheared round its edges, and the rest of the stroke is only required to push out the plug. Examination with a shaping machine shows that the plug is at first cylindrical and that the action of the punch is a shearing one; later on, the plug takes the form of two truncated cones, with their larger ends at the plate surfaces and their smaller ends together at the middle of the plate. When the die is not sufficiently larger than the punch, the hole made in the plate is of ill form, because of the crowding of the metal on the under side, where it then breaks off instead of flowing out. The diameter of the hole in the die should exceed the diameter of the punch by about one-fifth of the thickness of the metal to be punched.

A series of tests of non-conducting coverings for boilers and steam pipes has recently been made, at the instigation of an American insurance company, by Prof. Charles L. Norton, of the Massachusetts Institute of Technology, says the Engineer. His tests were made by a new method, which consists in filling the pipe under trial with oil and heating the oil by a wire immersed in it, which carries an electric current. The amount of heat radiated from the pipe is equal to the heat furnished by the current, which may be computed from the readings of a voltmeter and an ammeter. Prof Norton gives the following caution respecting the use of mineral wool as a steam pipe covering. It serves only as a non-heat conductor when in a very light and fluffy condition, holding entrapped air. It is liable to be consolidated by the vibration of the factory, leaving the upper part of pipes exposed, while the lower side is only guarded against radiation by this material becoming more and more solid, and therefore less fit for its purpose. But this is not the worst. It is dangerous stuff to handle. The fine needles getting under the nails will produce very injurious effects, and it is not safe to handle this material even in a laboratory without carefully protecting mouth and nose from the dust, which, when breathed, has produced hemorrhage. Much of this slag also contains sulphur or other elements, which, when wet or even dampened by escaping steam, become very corrosive. Another type of a similar kind is known as rock wool. This appears to be made from glass, and is therefore without corrosive effect, but is even more dangerous to handle than the mineral type.

ELECTRICAL NOTES.

The first meeting of the committee formed for the purpose of promoting the International Submarine Telegraph Memorial was held in London. An executive committee was appointed.

As the result of the installation of an electric driving plant, and the use of a separate motor to each machine, the coal consumption at Sir William Gray's shipyard, West Hartlepool, is said to have been reduced from 72 tons to 38 tons per week.

Portable electric lamps have lately been introduced in the collieries at Sekul, Hungary, in place of ordinary safety lamps. The lamps, which were supplied by the Bristol Accumulator Works, of Vienna, are each provided with a small secondary battery, the weight of the set being 2 kilog. The lamp gives from 1½ to 2 candle power, the accumulator being able to maintain this for ten hours.

The success attending trolley express lines has been noted. Another of these lines has been added to the list. An express company has been organized independently of the railway for an express service on the Bangor, Me., Orono & Oldtown Electric Railway. The company, which is capitalized for $10,000, proposes to collect, carry and deliver goods, fill business orders, collect bills and notes, carry United States mail and perform all the functions in a small way of the big express companies. One car is already in service, and more are building. A charter was obtained in Massachusetts about a year and a half ago for doing an express business on the electric roads of Boston and suburbs; but, as yet, the corporators have not made a move to utilize their valuable franchise.

Electric motors are becoming popular in many industrial operations hitherto worked by hand or steam. They have in some instances been applied to rolling mills, and, it is said, with marked success. A motor of some 15 horse power is placed on one of the housings of a steel plate rolling mill for the purpose of raising and lowering the top roller. The gear in connection with the motor is constructed for giving motion to either or both of the lifting screws. The brake arrangement permits of starting and stopping the motor promptly, and the rolls can be adjusted quickly and accurately with the utmost facility. If electric motors are found in practice to do all that is claimed for them in this application, their use will effect considerable saving in toilsome labor, and will doubtless be very quickly adopted by all important rolling mills.

M. Raoul Pictet, says Industries and Iron, has recently filed his specification of what seems an important modification of the present system of making calcium carbide, and one which, if successful, would appear to promise a considerable saving in the cost. It is well known that all the furnaces now producing calcium carbide utilize the electric current as the source of heat. M. Pictet's furnace dispenses with electricity for this purpose, and employs the current only for the purpose of terminating the reaction. For this purpose M. Pictet uses a vertical furnace divided into three parts or zones of temperature. The furnace is charged with the materials from the top, and they descend by their own weight through two preliminary stages, where they are subjected to the action of a progressively increasing temperature, created by a hot blast, till they reach the floor, where an electric arc flashing between two strong electrodes finishes the operation. The carbide flows through an orifice to the receptacle below. The furnace is double lined with refractory bricks of the best quality. It would appear that a considerable economy might be effected in the consumption of current, and it will, therefore, be interesting to have information as to the practical working of the process.

According to Wiedemann's Annalen der Physik und Chemie, No. 9, the effect of light on spark discharges is not a direct action, but is the consequence of the shortening of a process preceding the spark discharge, and this shortening is brought about by illumination. Mr. E. Warburg studied the shortening by applying the difference of potential more or less rapidly, and finding the lowest difference of potential capable of producing discharge within five minutes, this being the greatest delay observed. The discharge potential thus found he calls the statical discharge potential to distinguish it from the dynamic discharge potential producing sparks when the current surges to and fro. The experiments made by the author show that the statical discharge potential is not materially influenced by illumination. But when a difference of potential nearly seven times as high is applied for a few thousands of a second only, it always produces discharge when the cathode is illuminated by an arc lamp, and not in the dark. The range of potentials at which discharge only takes place occasionally is very small in the case of illumination, but large in the dark, says the Engineer. This is said to explain why a telephone connected with an illuminated spark gap gives a purer note than when it is not illuminated.

Vice-Consul J. F. Monaghan writes from Chemnitz, July 11, 1896:

"The number of electrical railways, street and other, went up in Europe during 1895 from 70 to 111; length of lines from 700 kilometers to 902 kilometers (1 kilometer equals 3,250 feet); power from 18,150 to 25,095; the number of cars (wagons), from 1,236 to 1,747. Germany, with 406 kilometers, leads the list. The following table shows the ratio of the different countries:

Country.	Kilometers.	Power.	Cars.
Germany	406·4	7,194	857
France	132	4,490	225
England	94·3	4,243	143
Austria-Hungary	71	1,949	157
Switzerland	47	1,559	86
Italy	39·7	1,890	84
Spain	29	600	26
Belgium	25	1,120	48
Ireland	13	440	25
Russia	10	540	32
Servia	10	200	11
Norway and Sweden	7·5	225	15
Bosnia	5·6	75	6
Roumania	5·5	140	15
Holland	3·2	320	14
Portugal	2·8	110	8

MISCELLANEOUS NOTES.

Large and rich gold fields have been discovered by government surveyors on the east coast of Siberia, bordering on the Sea of Ochotsk.

A circular disk of paper, three or four inches in diameter, is cut and lightly dropped on the surface of the water, care being taken that the top does not get wet. If the piece of paper is hand made, it will curve up all around the edges; if not, it will curl from opposite edges, says Paper Making.

A royal duchess and a German princess riding on a fire engine was the sight that gratified one quarter of London recently. The Duchess of Albany, with her sister, Princess Elizabeth of Waldeck-Pyrmont, visited the Southwark Fire Department, when a false alarm and a fire drill were arranged, and the princesses were driven to the fire on the machine.

The Berlin correspondent of the London Times says: "According to information received in Berlin, the building of the Church of the Redeemer in Jerusalem is being vigorously carried on. The roof and the tower are both nearing completion, and the furnishing of the interior will, it is stated, be begun during the present year. The chief interest taken by Germans in the progress of the sacred edifice lies in the fact that the German emperor has supplied the designs for both the pulpit and the tower."

In the issue of the Labor Gazette for July some details are given respecting British profit sharing in 1895-96, showing that "the total number of persons employed by the eighty-five firms now practicing profit sharing, and as to which particulars on this point have been received, is—minimum, 23,947; maximum, 26,187. Tables are given showing the number of working hours per week of the employes of workmen's co-operative distributive societies in Great Britain, and there is, too, a summary of the report for 1895 of the chief inspector of factories.

The production of coal in India is steadily increasing. In 1885 there were mined 1,295,000 tons, while last year the figures were increased to 3,167,000 tons. The Bengal collieries are responsible for about two and a half millions of the total. Much attention has also been paid of late years to the discovery of mineral oil wells, but the success attained has not yet been encouraging so far, though some 36,000 gallons of oil were obtained from the Digboi field in 1895. The boring at Sukkur has failed to reach an oil bed, though it has been carried to a depth of 1,500 feet, and is to be sunk 200 feet further before being abandoned.

The recent discovery of chrome ore at and the arrival in Philadelphia of a cargo of it from Port au Port, a small settlement in Newfoundland, thirty miles northeast of Cape St. George, "marks a new departure in the shipping industry, and promises the opening up of a large trade between Newfoundland and Philadelphia." This small cargo "is brought here only as a sample, and if found to be up to the standard of that quality of ore brought here from South America, larger vessels will be put into the trade, and arrangements for the working of the newly discovered mines on a larger scale will at once be made."

The manufacture of paper in Finland has increased to such an extent in recent years that it now forms one of the most important industries in the country. There are, according to the Papier Zeitung, thirteen paper mills, seven chemical pulp factories, three straw pulp and twenty wood pulp and pasteboard factories. The number of workmen employed in these different factories amounted to 3,847 in 1894. In 1893 the production amounted to 32,000 metric tons of mechanical wood pulp, 8,000 of chemical, and 7,500 of paper. The factories chiefly employ English machines, but recently German and Swiss makers have received orders. The total number of paper machines in Finland is twenty-six. Two mills only make rag paper; two mix rags with first-class paper; three add straw pulp; and all the others make wood paper exclusively, and at need employ chemical pulp. The rags are imported from Russia, the total imports being 1,220 metric tons in 1891, 867 in 1892, and 727 in 1893.

Carolina monazite occurs in irregular crystals, some being as large as a grain of wheat, and requires crushing, for which reasons the Auer-Welsbach Company, of Berlin and Vienna, prefers the Brazilian monazite which comes in the form of a fine sea washed sand. A ton of Brazilian monazite sand, costing at present in Hamburg $119, yields, when well worked out, from 20 to 25 kilogrammes of pure thoria, which is worth from $2,400 to $3,000, according to degree of purity. Thorium oxide is now worth in Germany from $120 to $150 per kilogramme, according to purity, and Mr. Mason, consul at Frankfort, suggests the establishment in the monazite region of this country of a laboratory "where by employing the most improved and economical methods, the monazite, including the poorer sands which have been concentrated by a process recently perfected, may be worked up, the thoria extracted and made available as a finished product in all countries where incandescent gas burners are manufactured."

The restoration of the Arc de Triomphe in Paris is a slow work, and the promenaders of the Champs-Elysées are grumbling over the scaffolding, which they consider is destined to be never removed. But more than a year will have to elapse before the structure emerges from the forest of squared timber. The architect, M. Esquié, who has charge of the operations, finds it is not easy to do all that is needed with £11,000, the sum assigned to the work, and it is likely that £2,000 in addition will have to be expended. The arch was commenced in 1806, and was not completed until thirty years afterward. Builders were not more fortunate in discovering sound stone in those days than in our own. The stone, which was obtained from quarries at Chérence (Seine-et-Oise), was porous, and during sixty years it has been deteriorating. Similar stone has to be employed in the restoration, and there is consequently a guaranty that restoration will again become necessary before the next century has been long in evolution. The work must be slowly done, for it is not possible to remove many stones at one time, and apparently the quarrymen are co-operating in the promotion of delay, by supplying stone in very limited quantities.—The Architect.

THE GENUS ERYTHRONIUM.

THIS genus of liliaceous plants is chiefly known, perhaps, from its only representative on this side of the Atlantic Ocean, viz., E. Dens-canis, commonly known as the Dog's Tooth Violet. There are at present not more than a dozen species altogether known to botanists, and with the exception of E. Dens-canis, these are natives of the United States and Canada. Small though the genus be, it has not failed to give a certain amount of trouble to botanists so far as identification and nomenclature are concerned. The species shown is named in honor of one of the Royal Horticultural Society's collectors—Theodor Hartweg. He collected it on the mountains near Sacramento about 1836. The late Mr. Bentham, however, in his Plantæ Hartwegianæ, published in 1839, simply refers to it as E. grandiflorum, Pursh.; but Dr. Sereno Watson, in the Proceedings of the American Academy of Arts and Sciences, xiv, 261, describes it as a new species. The illustration will give an idea of the habit of growth and size of the flowers. The upper surface of the green leaves is marbled with dull purple. The flowers are, as a rule, solitary, but two or even three may be produced on the same peduncle. They remain in good condition for three or four weeks. The segments are cream colored, with a more or less orange zone at the base.

ERYTHRONIUM HARTWEGI—COLOR OF THE FLOWERS WHITE AND YELLOW.

THE WORLD'S GOLD YIELD.

THE gold yield of 1895 was by far the largest in the history of the world—something over $200,000,000. Enough reports have been received from the different gold fields of the world to show that this will be considerably increased for 1896. With little exception, there will be an increase in all the large gold producing districts of the world, and many new districts which were hardly noticed before will come forward with large figures.

In California, throughout the entire gold region, there has been more activity and development than ever before. While this will not cause a large increase in the output of 1896 over that of 1895, for the reason that many of the mines being developed will not begin to produce bullion for one or two years, yet the newly opened mines and the large increase of activity will materially add to the bullion yield of last year. Much the same may be said of Colorado. The output of Cripple Creek promises to be about $2,000,000 more than that of last year. New gold mines have been opened in other parts of that State, and the total yield should be considerably increased.

Nevada has not been counted among the gold producing States heretofore, but the opening up of the immensely rich mines about Pioche, State Line and smaller mines in other parts of the State promises to make the gold yield of that State of considerable importance. In Montana, Idaho, Wyoming and Colorado there has been a great deal of activity in gravel mining. Not enough has been done to make much addition to the gold yield of this year, but there can be little doubt that the gravel deposits in these States will in time yield large sums.

In Alaska there has been an increase of the gold yield, and there will be a greater increase next year. British Columbia will do more for the increase of this year's output than any other single new district. Further east, in the British possessions, new gold mines are being opened up. In South America there is some new interest in gravel mines. Several California engineers have been called there to take charge of or exploit mines for British syndicates. In Australia activity in mining has been greater than ever before, and the output of gold should be larger than that of last year. In South Africa the output for the last two months is the largest on record. The output of the mines of Russia last year was estimated at $34,000,000, and there is more being done this year than there was last.

There can be little question that in nearly all these districts named the output of gold will increase for several years. The query then becomes, not as to whether there will be an abundant supply of gold for the next few years to come, but how long will it hold out.

The reduction of the cost of working and milling ores has been the cause of opening up many mines that would otherwise have remain untouched. Many reports are received of cases where the cost of both milling and mining is less than $2 a ton. The main problems for mining engineers will be in this direction. A small reduction in the cost means the opening up of many mines already known to exist that would otherwise remain valueless. In South Africa, for example, of the numerous parallel reefs, as they are called, at first only one—the richest—was worked; now two, and sometimes three or more are opened. A large majority of these reefs, adds the Mining and Scientific Press, are of such low grade that with the present methods they cannot be worked, and the question as to how much the future output will be depends entirely upon the reduction in the cost of the working.

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